The SPURS-2 field campaign: Data from an oceanographic experiment in the eastern tropical Pacific

A report prepared by

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Abstract

This document describes the *in situ* data collection resulting from the SPURS-2 (Salinity Processes in the Upper Ocean Regional Studies - 2) field campaign in the eastern tropical Pacific. The campaign lasted approximately 15 months from August 2016 to November 2017, and aimed to understand the role of rainfall in creating the surface salinity field that is observed under the intertropical convergence zone. The data collection was a collaboration between many different institutions and mostly funded by NASA, with contributions from NSF and NOAA. It was mainly a US program, but had some French participation. The data collection is large and diverse, consisting of shipboard data from a series of cruises, Lagrangian instruments, autonomous platforms and 3 deep moorings. Quantities measured include upper ocean salinity and temperature on a variety of scales, rainfall, and surface fluxes of heat and moisture. Most of the data collected during SPURS-2 are now available at the mission page at the Physical Oceanography Distributed Active Archive Center at NASA's Jet Propulsion Laboratory, https://podaac.jpl.nasa.gov/datasetlist?ids=Collections&values=SPURS-2&search=spurs&view=list.

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1 Introduction

See section 7 for a list of abbreviations used in this report.

This report documents data collected from the SPURS-2 field campaign in the eastern tropical Pacific during 2016-2017. SPURS-2 was an international, multi-investigator project whose goals were discussed in detail by SPURS-2 Planning Group (2015) and Lindstrom et al. (2017). Briefly, the purpose was to study the dynamics of the rainfall-dominated surface ocean at the western edge of the eastern Pacific fresh pool (Alory et al., 2012). Some science questions that the study sought to address were “how does the ocean integrate the freshwater forcing and destroy variance created at the surface?” and “what are the local and non-local effects of freshwater flux on the ocean?” (SPURS-2 Planning Group, 2015). This part of the ocean is highly seasonal (Guimbard et al., 2017; Fiedler and Talley, 2006) and subjected to strong zonal flows associated with the North Equatorial Current and North Equatorial Countercurrent (Kessler, 2006). Much detail on the scientific results of SPURS-2 was published in the June 2019 issue of *Oceanography*. A description of the data collection in the same issue was given by Bingham et al. (2019). All the archived data can be found at the SPURS-2 mission page at PO.DAAC, https://podaac.jpl.nasa.gov/SPURS. The data collection can be accessed directly at https://podaac.jpl.nasa.gov/datasetlist?ids=Collections&values=SPURS-2&search=spurs&view=list (Earthdata login required to download). A complete and updated table of the measurements can be obtained at https://podaac-tools.jpl.nasa.gov/drive/files/allData/insitu/L2/spurs2/docs/DataDocumentation/SPURS2Datasets_DOIs&References.pdf. This table and the Bingham et al. (2019) paper should be viewed as companions to this report, or alternatively, this report and the table should be viewed as supporting information for that paper.

The SPURS-2 field campaign consisted of a large variety of in situ instrumentation, autonomous, drifting, ship-based and moored. Some of the instruments were very standard (e.g. CTDs) and others very unusual or innovative. The activity was centered at a central mooring located near (10°N,125°W), with two other moorings deployed to the north and south of it (Fig. 2.1B). There were two major cruises on R/V Roger Revelle (Table 1 and Fig. 2.1), for deployment in Aug-Sep 2016, and recovery in Oct-Nov 2017. In addition there were 8 cruises on the LA for light deployment and recovery (Table 2 and Fig. 2.2).

1.1 Data elements

The full list of SPURS-2 datasets shows the heterogeneity of the collection. For the sake of organization, they are divided loosely into categories here. Dataset numbers refer to this document:

https://podaac-tools.jpl.nasa.gov/drive/files/allData/insitu/L2/spurs2/docs/DataDocumentation/SPURS2Datasets_DOIs&References.pdf

Category (dataset numbers)

Ocean (1-15, 17-22, 25, 26, 28, 29, 31, 34-39, 44-53, 55, 56, 58)
Atmosphere (16, 23, 24, 27, 32, 33, 39-43, 54, 57)
Ocean-Atmosphere flux (16, 20, 27, 30, 32, 33, 35, 39, 42, 43, 54, 57)
***
Physical
- Currents (1-6, 18, 19, 21, 22, 29, 34,)
- Temperature/salinity (7-15, 17-22, 25, 26, 28, 34-36, 39, 44, 45 ,55, 56, 58)
- Waves (31)

Chemical (50, 51)
Biological (7, 8, 36-38, 52, 53)
***
Drifting (15, 16, 19-22, 34)
Stationary (16, 23-30)
Mobile (17, 18, 36, 39)
Underway (Revelle / LA) (1-14, 31-33, 35, 37, 38, 40-56)
***
Skin (≤ 2 cm) (44-51)
Top (2 cm to 5 m) (7-15, 17-22, 25, 26, 28, 31, 34-39, 50-53, 55, 56, 58)
Deep (≥ 5 m) (1-12, 15, 18, 22, 25, 26, 28, 29, 34, 38, 52, 53)
1-12, 15, 18, 22(?), 26, 27, 29, 30, 33, 50, 51)
***

2 Cruises

Much of the SPURS-2 data collection was gathered on two ships, the R/V Roger Revelle (the “Revelle”) and the LA.

2.1 Revelle

There were two cruises on the Revelle where SPURS-2 instrumentation were deployed or recovered (Table 1). Cruise reports were produced with further details about the operations (Drushka, 2018; Jessup et al., 2016).

Table 1. Information about Revelle cruises.

Cruise number	Departure date / port	Completion date / port	UNOLS Cruise designation	Data URL	Chief Scientist (institution)
1	13-Aug-2016 / Honolulu	23-Sep-2016 / Honolulu	RR1610	http://www.rvdata.us/catalog/RR1610	A. Jessup (U. Washington)
2	16-Oct-2017 / San Diego	17-Nov-2017 / San Diego	RR1720	http://www.rvdata.us/catalog/RR1720	K. Drushka (U. Washington)

During the 2016 cruise (“cruise 1”), the Revelle deployed 3 moorings, 3 wavegliders, 3 seagliders, 6 dual-sensor (AOML) drifters, 5 SVP drifters, 10 regular profiling floats, 5 profiling floats with PAL, 3 SURPACT drifters. The ship did 50 CTD casts, 82 atmospheric profiles from rawinsondes. As it was in motion, the ship collected pCO2, DIC, DO2 and pH data, surface salinity data from a salinity snake, temperature and salinity from three ports in the hull, 262 uCTD casts, 19 tows of the surface salinity profiler, 25 XBT casts, velocity profiles from three different ADCP systems and skin surface measurements from a dedicated IR radiometer. (Jessup et al., 2016)

During the 2017 cruise (“cruise 2”), the Revelle recovered all 3 moorings. It recovered two wavegliders (one had been previously recovered by the LA). One of the wavegliders was subsequently redeployed and recovered a few times. It deployed and recovered 2 ecomappers on two separate missions. It recovered 2 seagliders (one had been recovered by the LA). It deployed 2 SVP and 4 SVP-S, 5 CODE-type and one S-ADOS drifter as part of a “drifter experiment. It deployed 11 profiling floats, 2 of them being so-called “TPOS floats” with biogeochemical and PAL sensors. It deployed 4 CARTHE/SURPACT drifters. The ship did 15 CTD casts, 85 atmospheric profiles from rawinsondes. As it was in motion, the ship collected pCO2, DIC, DO2 and pH data, bio-optical data, surface salinity data from a salinity snake, temperature and salinity from three ports in the hull, 501 uCTD casts, 16 tows of the surface salinity profiler, 11 XBT casts, velocity profiles from three different ADCP systems, and skin surface measurements from a dedicated IR radiometer. (Drushka, 2018)

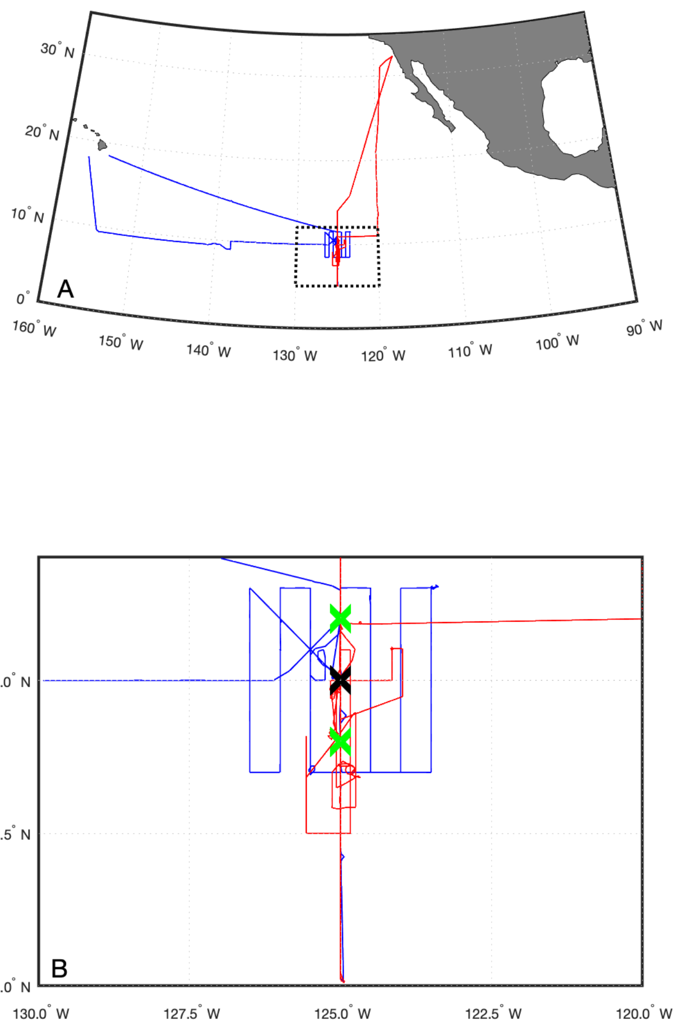


Figure 2.1. Tracks of R/V Roger Revelle for cruise 1 (red) and cruise 2 (blue). See Table 1 for cruise dates. Panel B boundaries are shown in Panel A by a dashed line. Black “X” marker in the lower panel is the nominal location of the central mooring. Green “X” markers are the nominal locations of the north and south PICO moorings.

2.2 Lady Amber

There were 8 cruises on the LA (Rainville et al., 2019, Fig. 2.2 and Table 2). The LA is a 20m long twin-masted schooner. It was outfitted with a thermosalinograph and meteorological instrumentation as detailed below. Deployment of instrumentation from a sailing vessel like the LA is a different way of doing oceanographic research in the modern age - perhaps a throwback to the distant past of the field. The LA was used for reasons of cost and convenience. The LA was able to return to the SPURS-2 site several times during the year-long field campaign, whereas the more standard Revelle was only able to get to the site at the beginning and end. The LA was used for light deployment and recovery of instrument platforms, and coordinated scientific activities with the larger and more mobile Revelle (Table 2).

Table 2. Information about LA cruises. See Fig. 2.2 for cruise tracks.

Cruise number	Departure date / port	Completion date / port	Drifters deployed	Wavegliders recovered	Wavegliders redeployed	Seagliders recovered	Seagliders deployed
1	9-June-2016 / La Paz	5-July-2016 / Honolulu	10 SVP-S				
2	29-Aug-2016 / Honolulu	25-Oct-2016 / La Paz	10 SVP-S, 5 SVP	2	2		
3%%	1-Dec-2016 / La Paz	16-Jan-2017 / San Diego	20*	2	1		
4	15-Aug-2017 / San Diego	21-Sep-2017 / La Paz	20*			3	2
5**	17-Oct-2017 / La Paz	1-Dec-2017 / San Diego	18*				
6	3-Jan-2018 / San Diego	11-Feb-2018 / La Paz	20*				
7	25-Mar-2018 / La Paz	30-Apr-2018 / San Diego	20*				
8	July-2018 / San Diego	Aug-2018 / San Diego	20*				

%All SVP-S
%%During this cruise, the LA recovered the Lagrangian float on 14-Dec-2016.
*Half SVP and half SVP-S.
**This cruise included joint operations with the Revelle.

Sensors on board the LA included meteorological (sonic anemometer, air temperature, relative humidity, radiometer and rain gauge), and oceanographic instruments (salinity snake and TSG). LA underway data were collected during cruises 2-7, but not on cruises 1 and 8. See section 3.6.3.

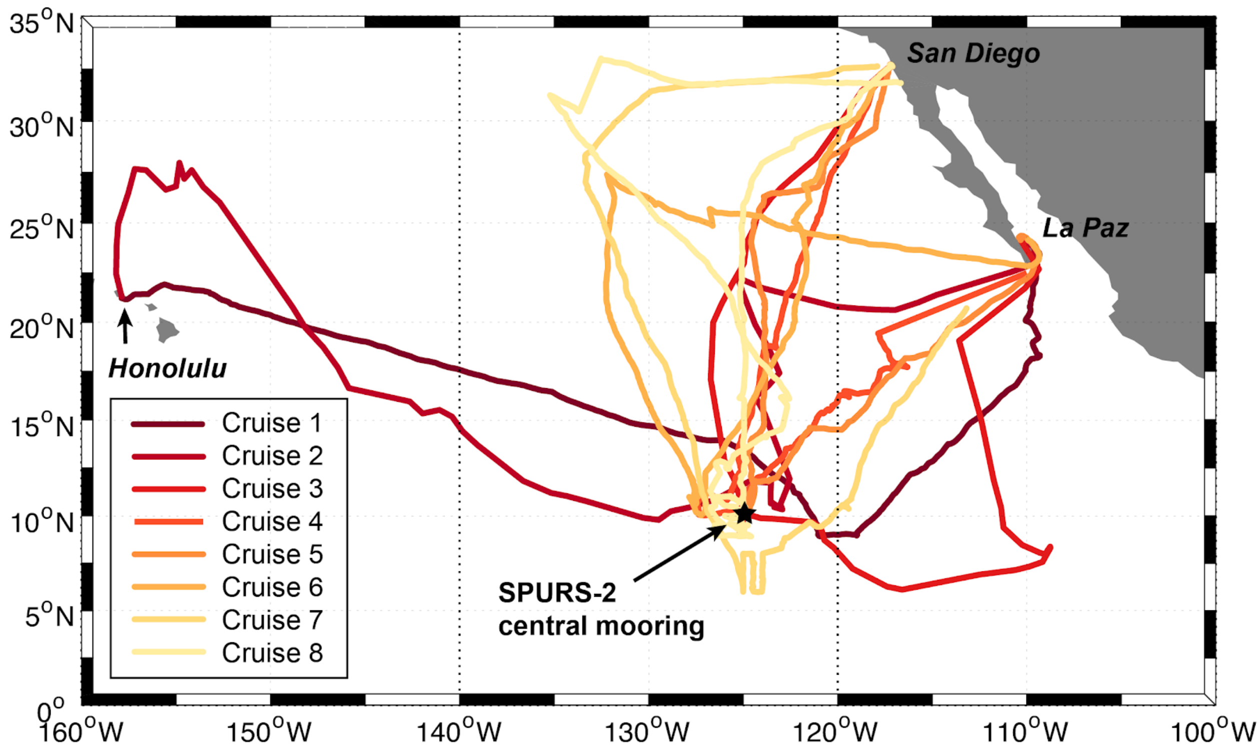


Figure 2.2. LA cruise tracks color coded as indicated in the inset. See Table 2 for cruise dates. Map courtesy of L. Rainville.

3 Instrument platforms and datasets

What follows is a description of the various instrument platforms utilized and datasets collected during the field campaign. Links are given to allow access to the various datasets, most of which are available, as stated above, at the PO.DAAC SPURS mission page, or the SPURS-2 data collection.

All data were archived as netCDF files conforming to CF1.6 and ACDD1.1 standards, using a set of templates from NCEI.

3.1 Standard shipboard data from the Revelle

The shipboard instrumentation from the Revelle were standard for a UNOLS vessel. The ones we report on here were those relevant to the physical oceanography associated with SPURS-2, namely the ADCP, CTD, TSG, XBT and meteorological data ("met data"). All shipboard data collected during the cruises including those not discussed here can be found at the URLs given in Table 1 or at the SPURS-2 data collection at PO.DAAC. Quality assessments of the various datasets discussed in this section can be found at http://get.rvdata.us/qa_inc/ using the cruise designations shown in Table 1.

3.1.1 Revelle TSG and met data

dx.doi.org/10.5067/SPUR2-USPS0

The TSG and shipboard met data from the Revelle cruises are distributed within the USPS data files at 5 second intervals. The ship's TSG intake was at about 5 m depth, whereas the USPS intakes were at 2 and 3 m (Asher et al., 2014). TSG data from the 2 m and 3 m intakes were corrected to make them compatible with actual conditions at 2 and 3 m depth. 5 m TSG data were not corrected.

Figure 3.1. USPS setup on the Revelle. See Asher et al. (2014) for more discussion.

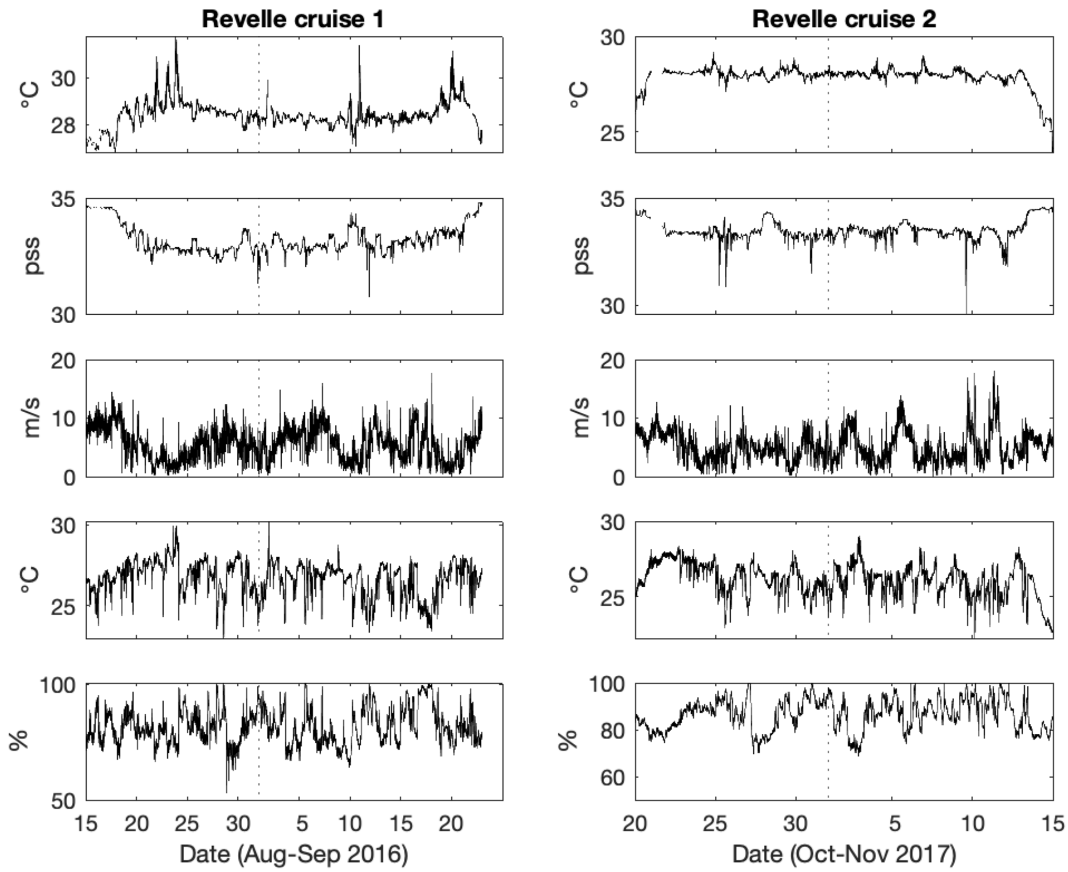


Figure 3.2. A sample of underway measurements from (left column / right column) Revelle cruise 1 / 2. Top row: SST from the 2 m intake. Second row: SSS from the 2 m intake. Third row: wind speed. Fourth row: air temperature. Fifth row: relative humidity.

3.1.2 Revelle ADCP data

dx.doi.org/10.5067/SPUR2-ADCP0

ADCP data were collected using three different instruments, an RD Instruments 150 khz broadband, a 150 khz narrowband and a 75 khz narrowband. The ADCP instruments were operating for essentially the entire time that the Revelle was in US or international waters on each cruise. (They were turned off in Mexican territorial waters during cruise 2.) Data files contain velocity profiles at approximately 2 minute intervals along ship tracks.

Figure 3.3. Teledyne RDI Workhorse Sentinel ADCP (Seatronics 2019).

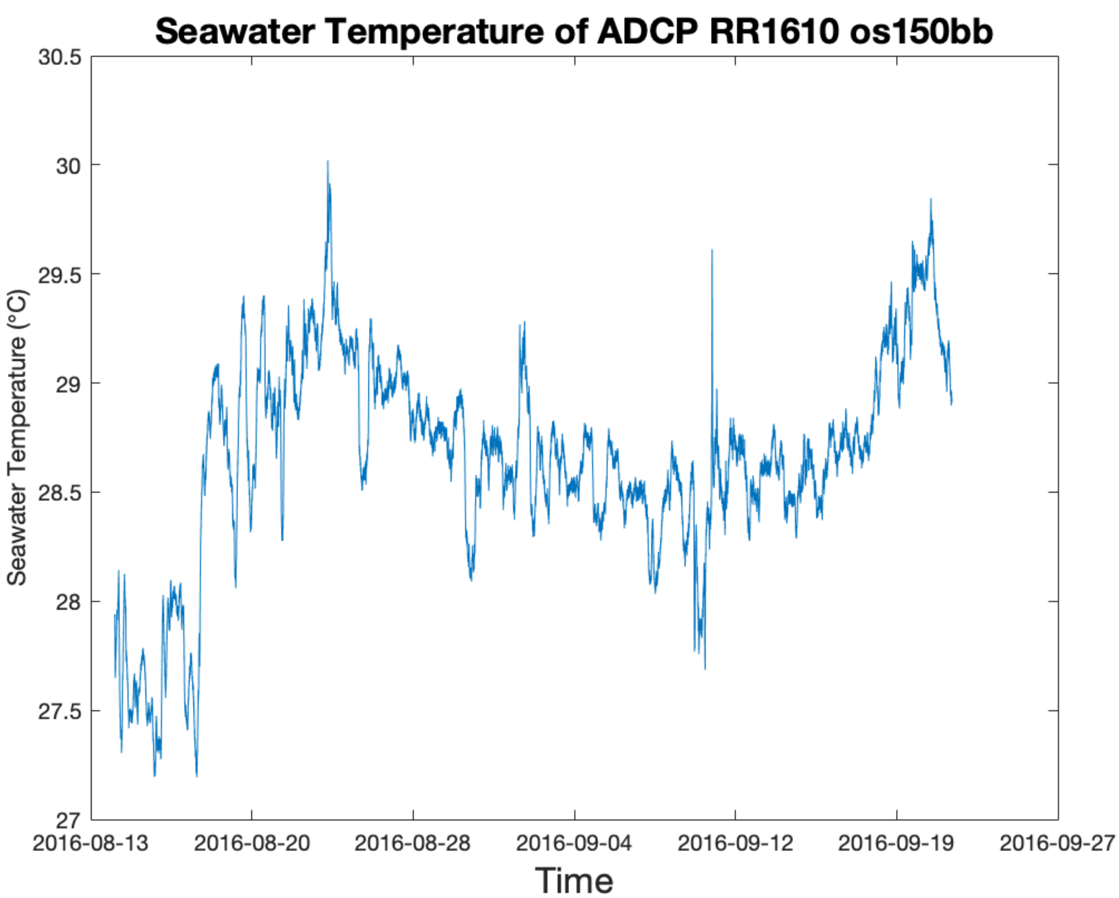


Figure 3.4. Seawater temperature of ADCP os150bb transducer during R/V Roger Revelle cruise 1.

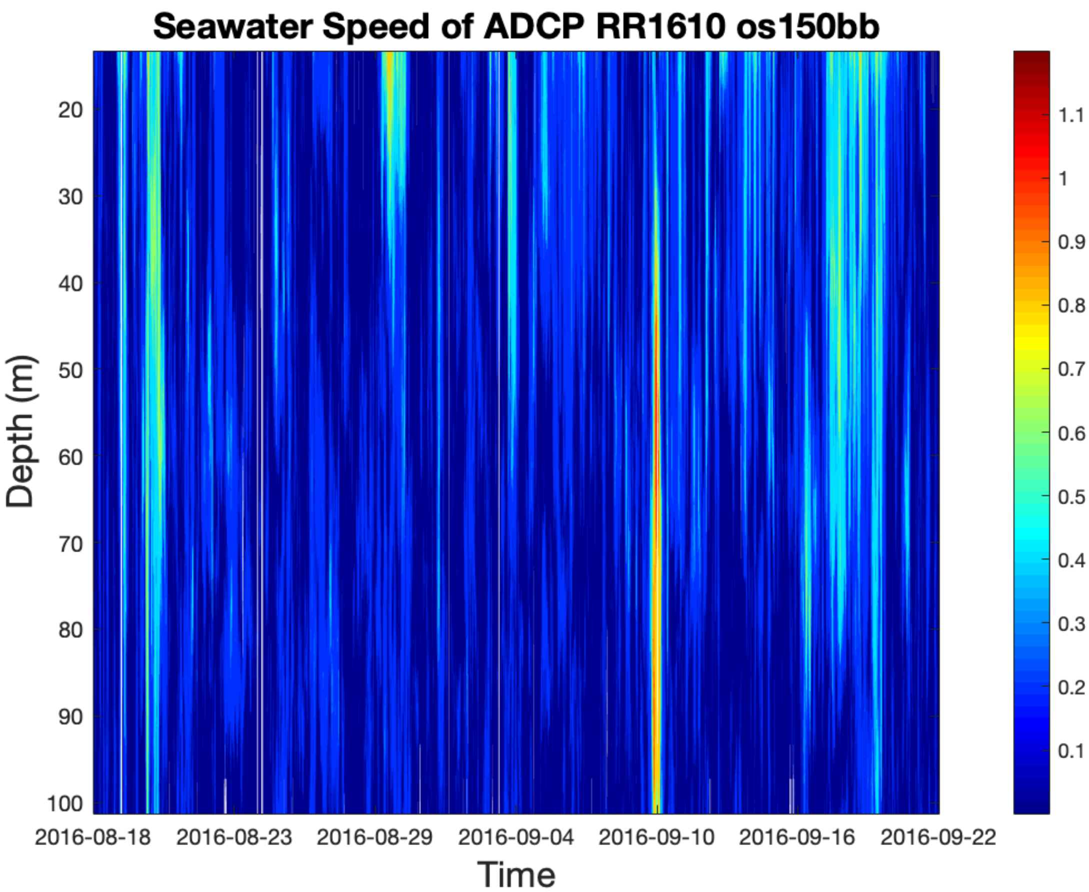


Figure 3.5. Seawater speed (m/s) with depth of ADCP os150bb during R/V Roger Revelle cruise 1.

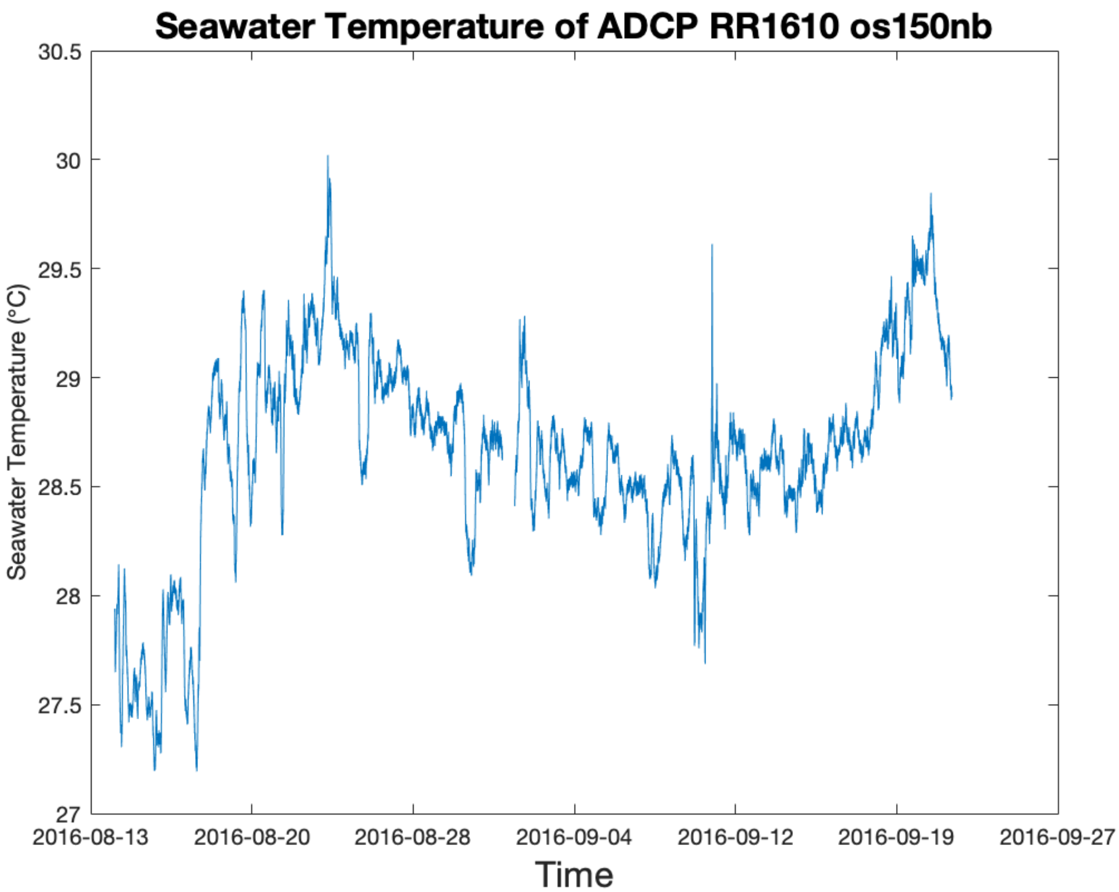


Figure 3.6. Seawater temperature of ADCP os150nb transducer during R/V Roger Revelle cruise 1.

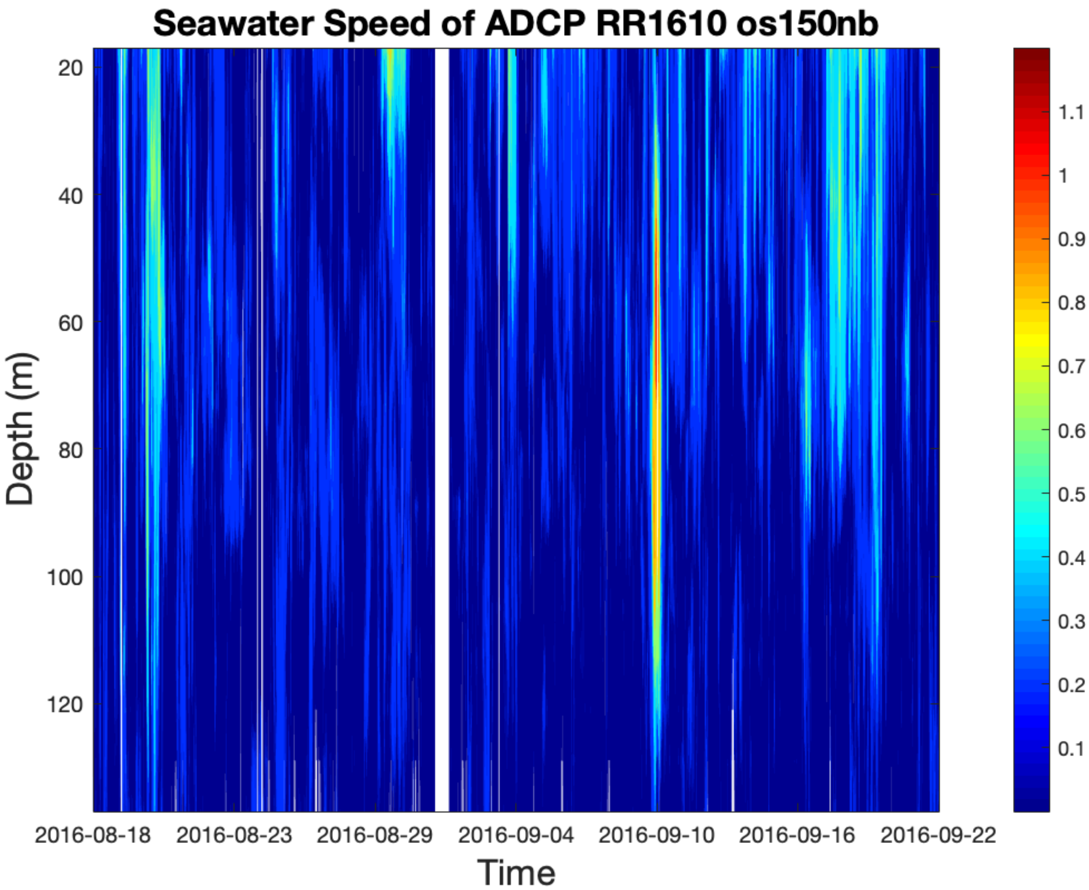


Figure 3.7. Seawater speed (m/s) with depth of ADCP os150nb during R/V Roger Revelle cruise 1.

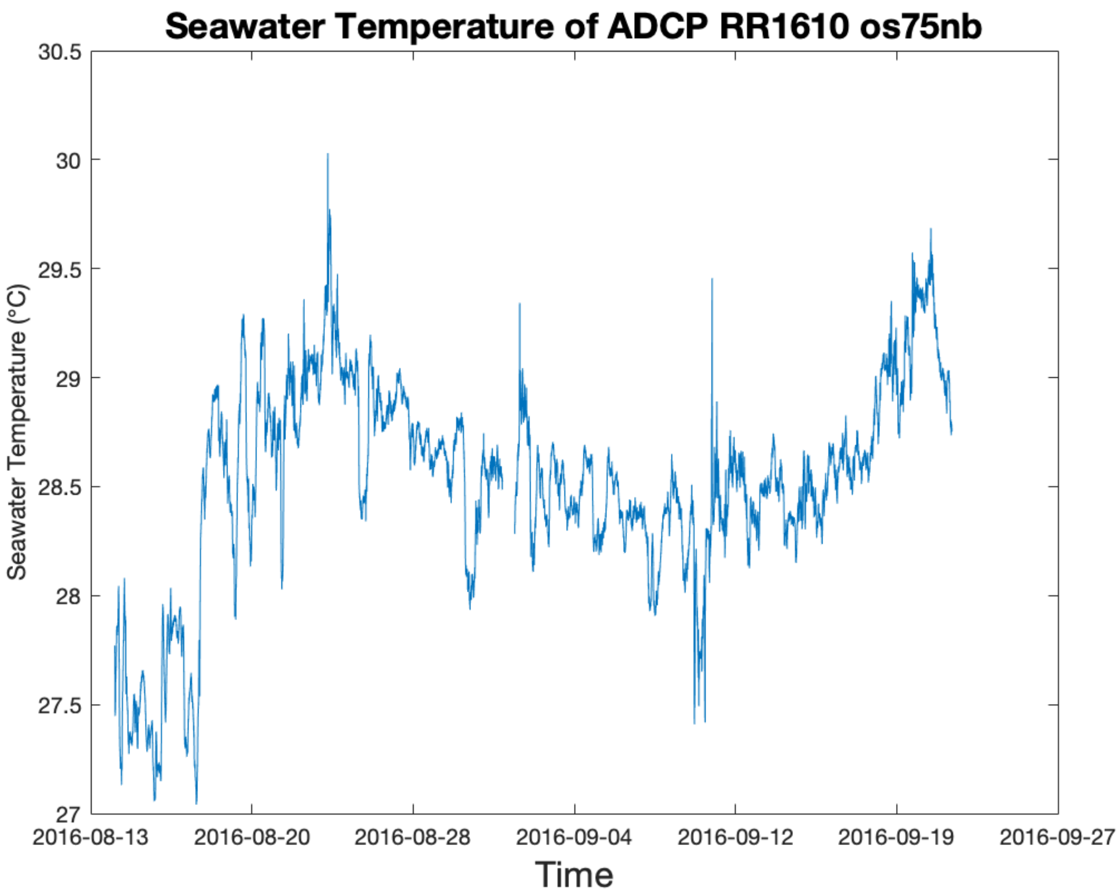


Figure 3.8. Seawater temperature of ADCP os75nb transducer during R/V Roger Revelle cruise 1.

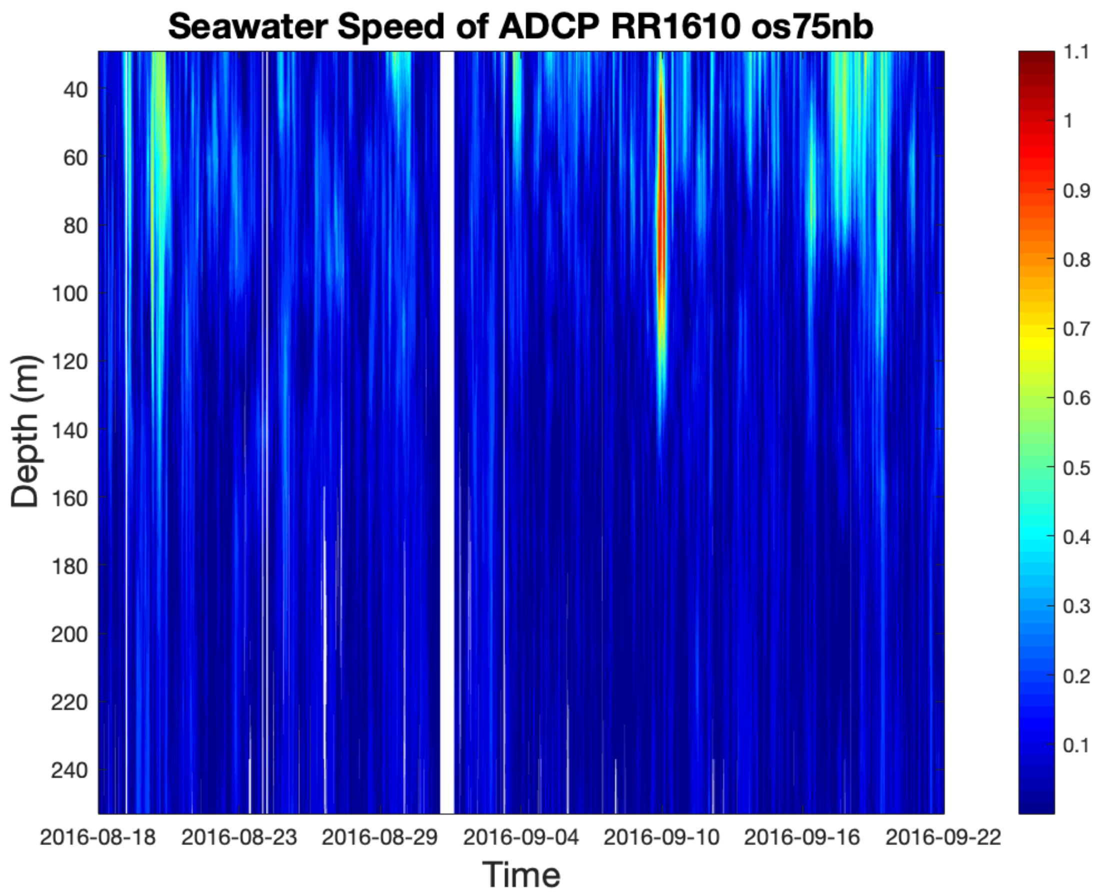


Figure 3.9. Seawater speed (m/s) with depth of ADCP os75nb during R/V Roger Revelle cruise 1.

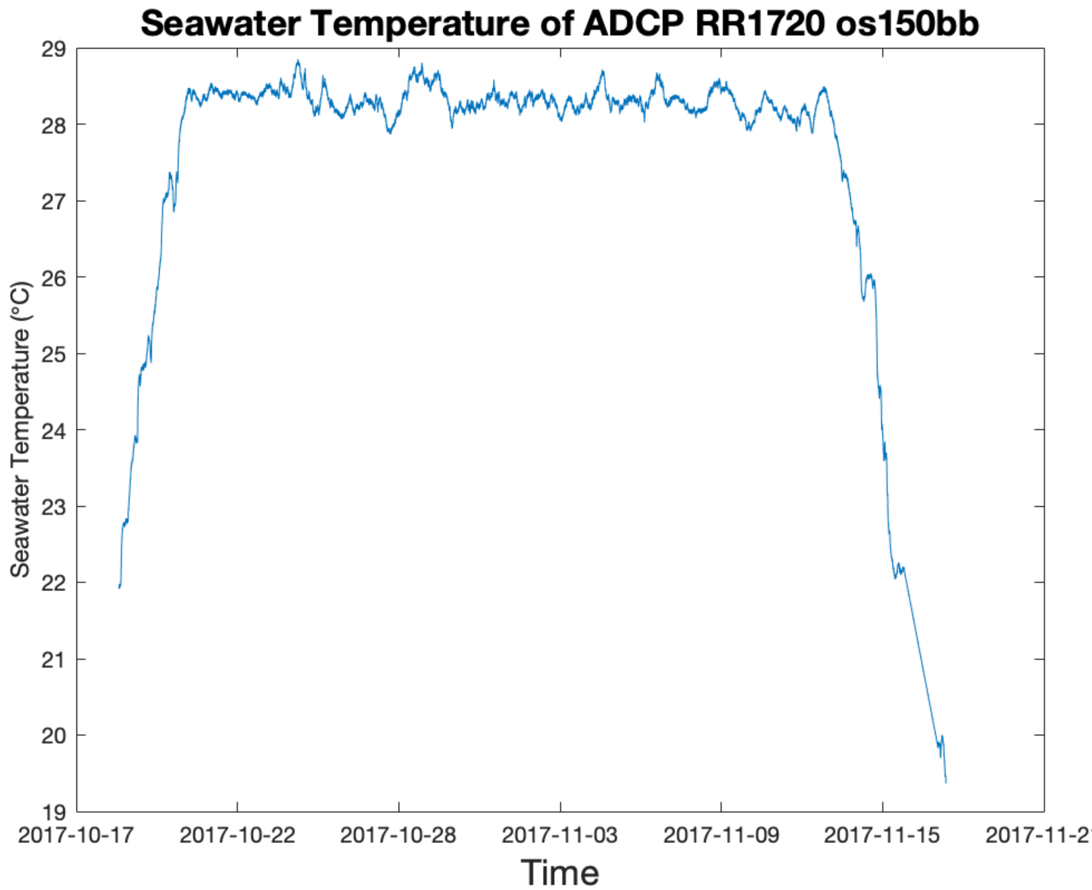


Figure 3.10. Seawater temperature of ADCP os150bb transducer during R/V Roger Revelle cruise 2.

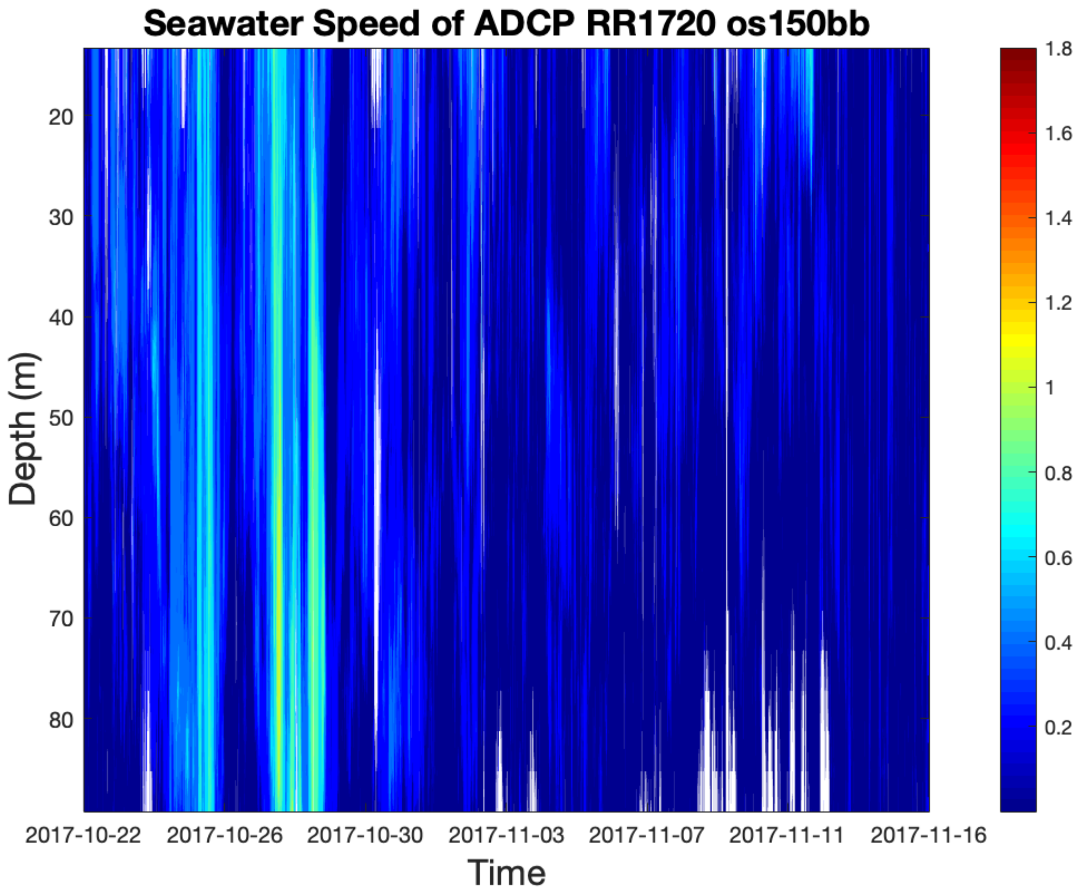


Figure 3.11. Seawater speed (m/s) with depth of ADCP os150bb during R/V Roger Revelle cruise 2.

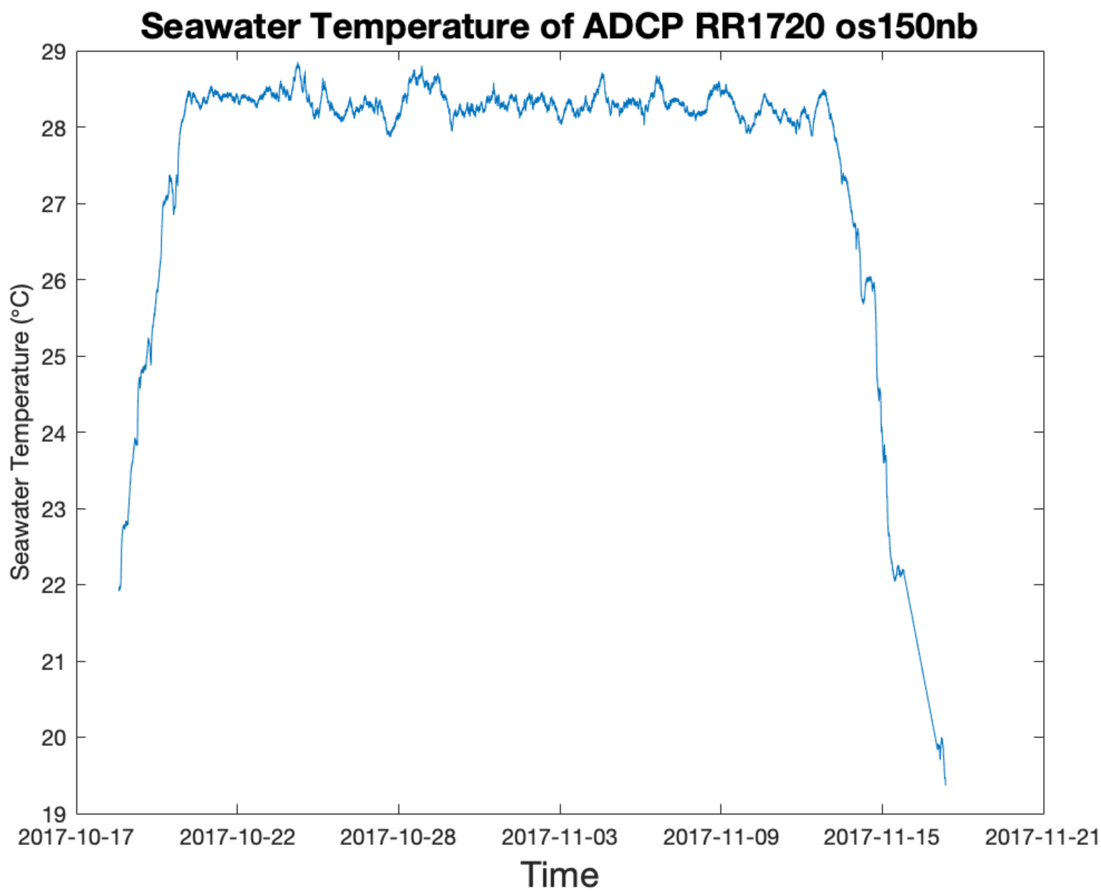


Figure 3.12. Seawater temperature of ADCP os150nb transducer during R/V Roger Revelle cruise 2.

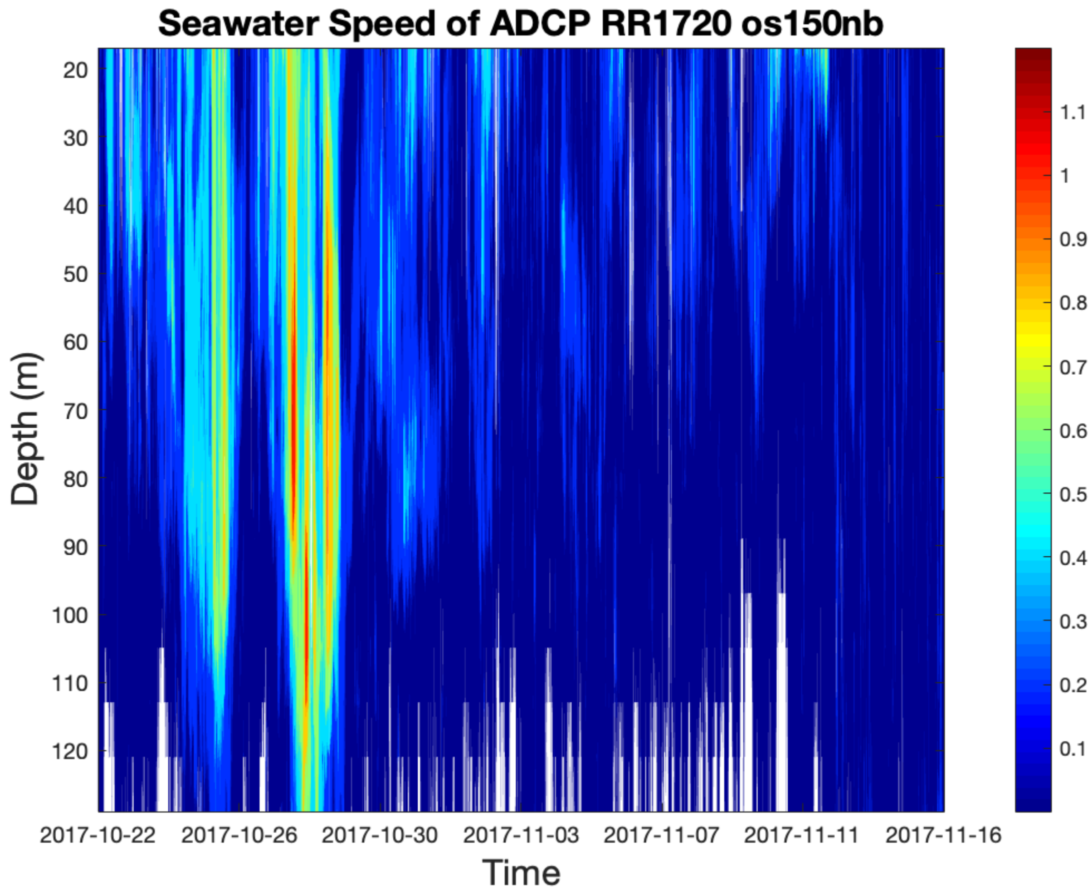


Figure 3.13. Seawater speed (m/s) with depth of ADCP os150nb during R/V Roger Revelle cruise 2.

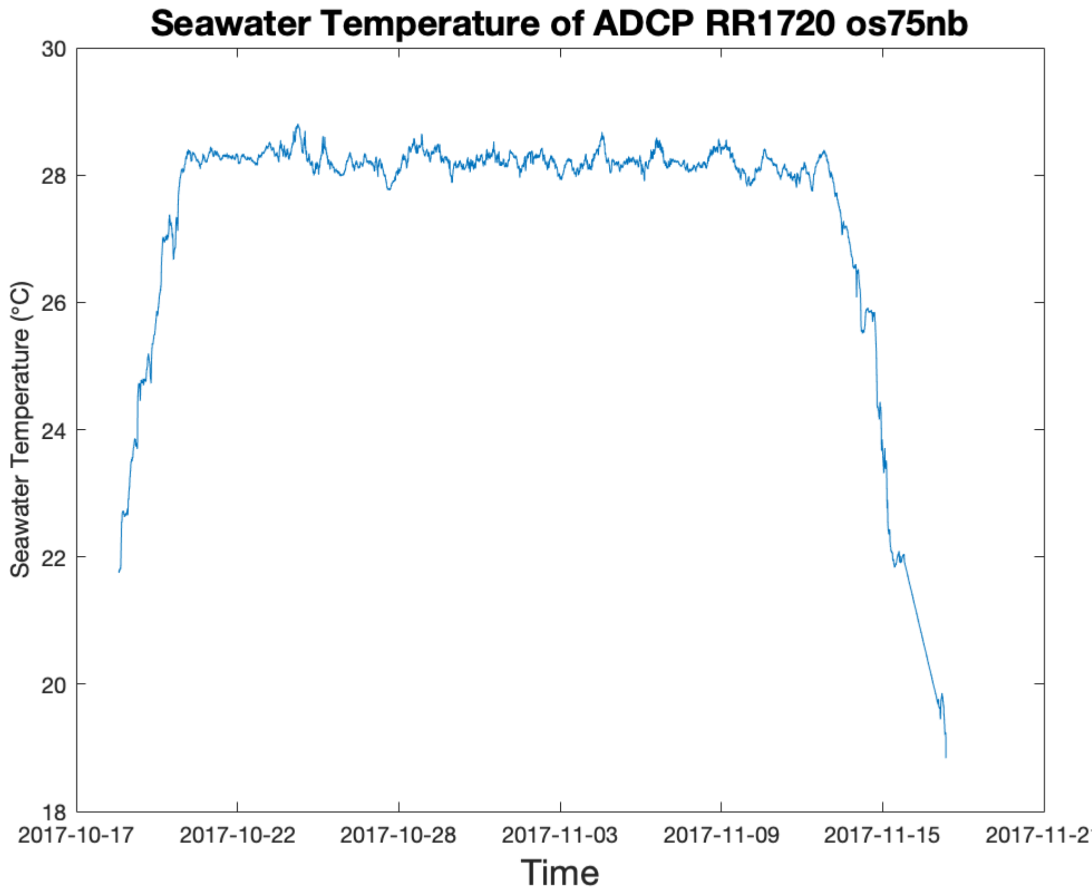


Figure 3.14. Seawater temperature of ADCP os75nb transducer during R/V Roger Revelle cruise 2.

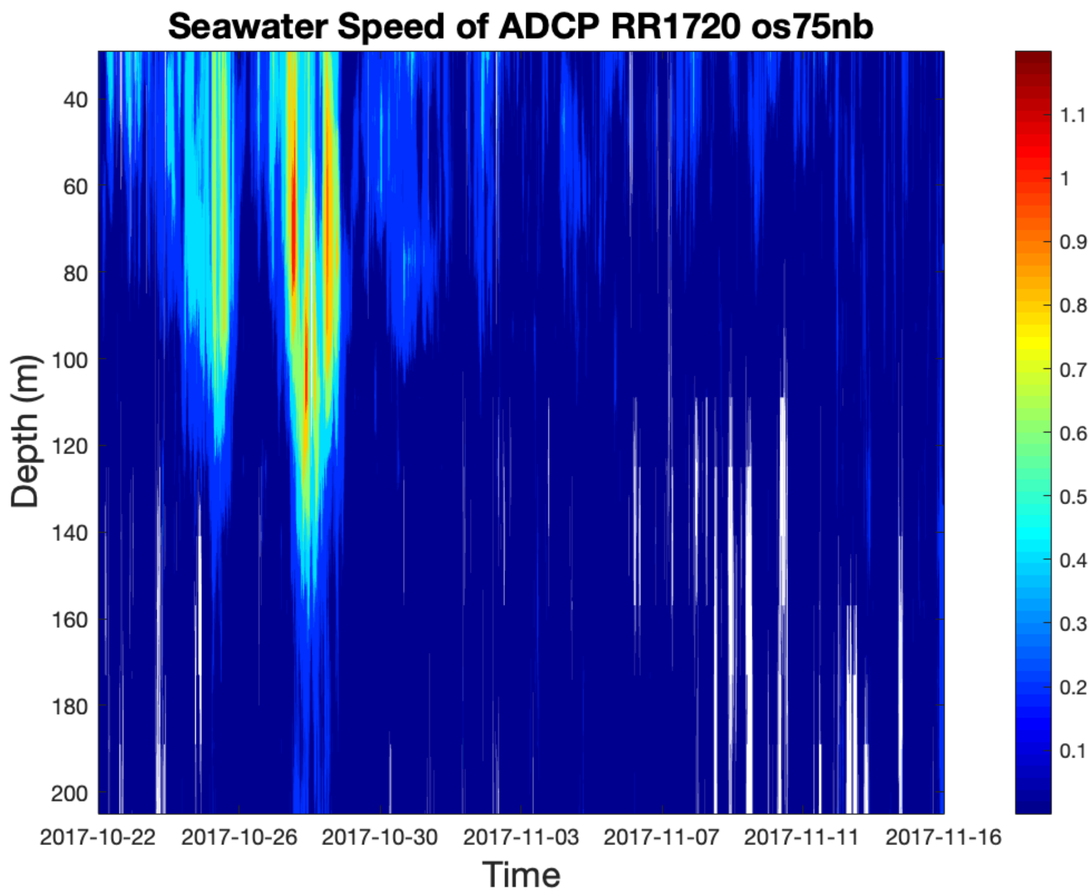


Figure 3.15. Seawater speed (m/s) with depth of ADCP os75nb during R/V Roger Revelle cruise 2.

3.1.3 Revelle XBT data

dx.doi.org/10.5067/SPUR2-XBT00

XBT casts were carried out on both Revelle cruises, 25 on cruise 1 and 11 on cruise 2.

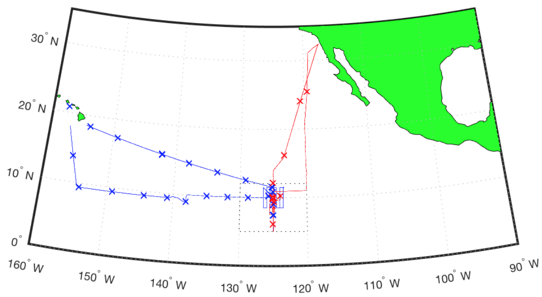


Fig. 3.16. Locations of XBT casts (x's) on cruise 1 (blue) and cruise 2 (red). Light dotted line shows the boundaries of Fig. 3.17.

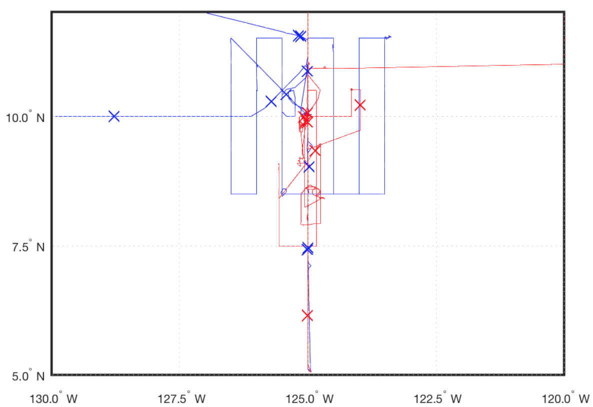


Figure 3.17. Locations of XBT casts (x's) on cruise 1 (blue) and cruise 2 (red).

Figure 3.18. Expendable bathythermograph (XBT) being launched from a vessel (Wikimedia Commons 2019).

3.1.4 Revelle CTD data

dx.doi.org/10.5067/SPUR2-CTD00

There were 50 CTD casts on cruise 1 and 14 on cruise 2 (Fig. 3.19). An overview of the procedures for processing the data can be found at https://scripps.ucsd.edu/ships/shipboard-technical-support/odf/data-services/quality-control. On cruise 1 (2), most CTD casts went to 1000 (500) m maximum depth. There were one deep cast on cruise 1 and one on cruise 2.

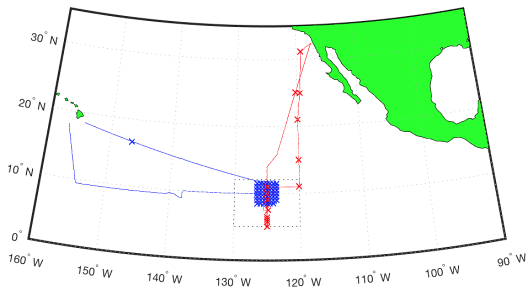


Figure 3.19. Locations of CTD casts (x's) on cruise 1 (blue) and cruise 2 (red). Light dotted line shows the boundaries of Fig. 3.20.

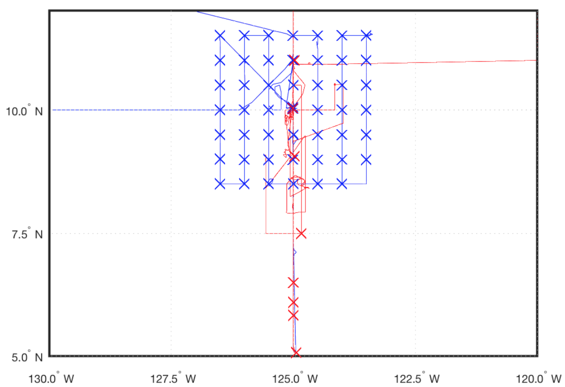


Figure 3.20. Locations of CTD casts (x's) on cruise 1 (blue) and cruise 2 (red).

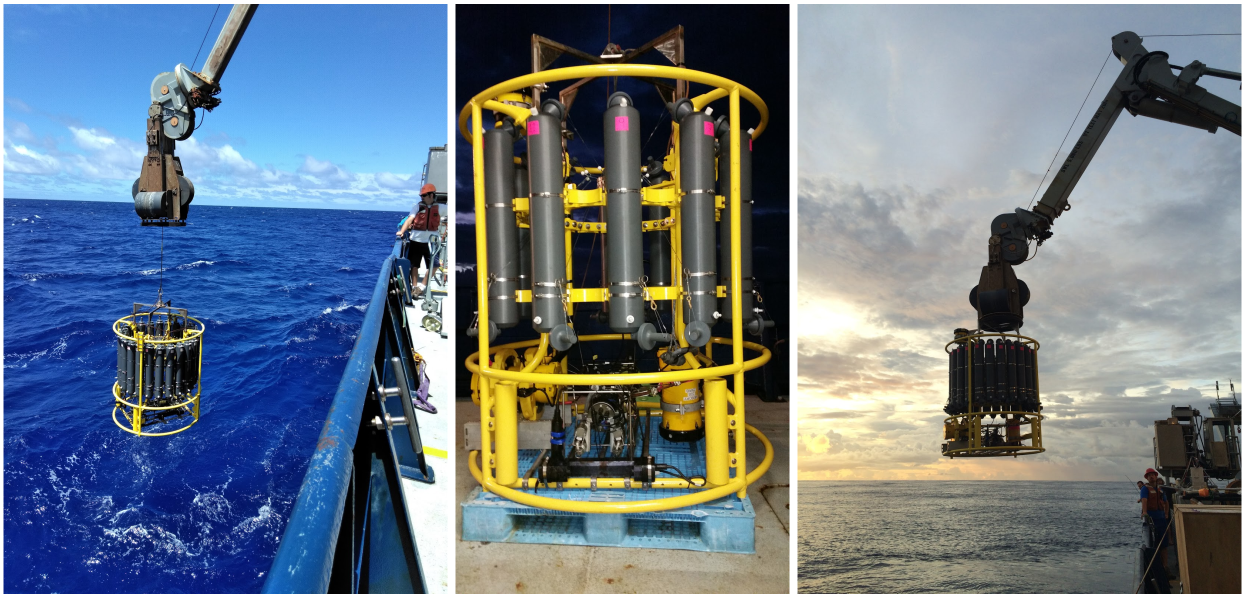


Figure 3.21. CTDs onboard and being deployed from R/V Roger Revelle. Photos courtesy of B. Greenwood, S. Kawamoto, and D. Volkov, respectively.

3.2 Other Revelle Data

Beyond standard instrumentation, there were a number of custom measurements done on the Revelle during SPURS-2.

3.2.1 uCTD data

dx.doi.org/10.5067/SPUR2-UCTD0

An Oceanscience underway CTD (uCTD) system was operated on both Revelle cruises (Fig. 3.22). There were 259 uCTD casts on cruise 1 and 493 on cruise 2 (Fig. 3.23). The uCTD data were processed according to the procedures detailed in Ullman and Hebert (2014).

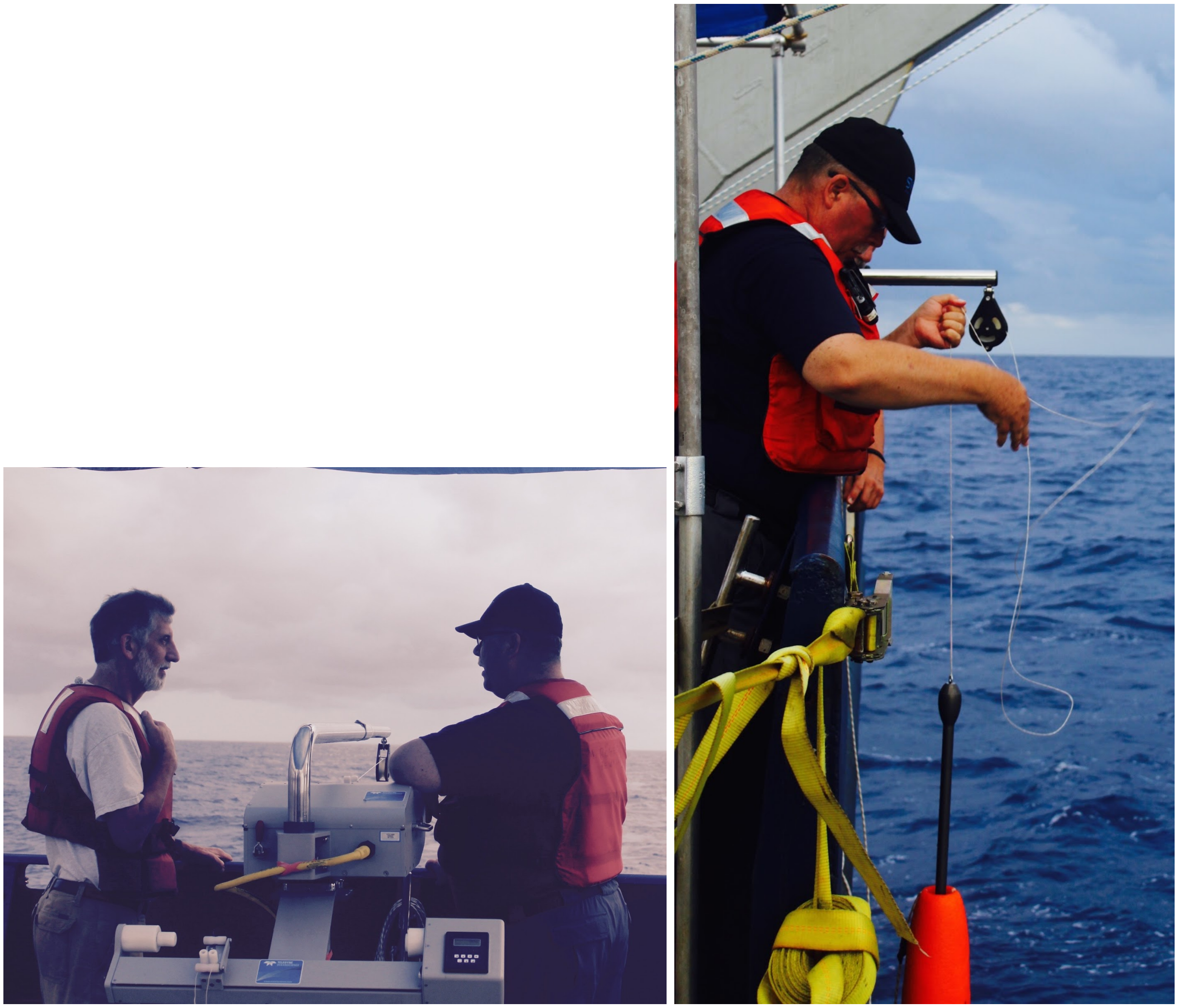


Figure 3.22. Left. uCTD deck assembly as the instrument is profiling. Right: The uCTD being recovered at the end of a cast off the aft of the Revelle. Photos courtesy of J. Sprintall.

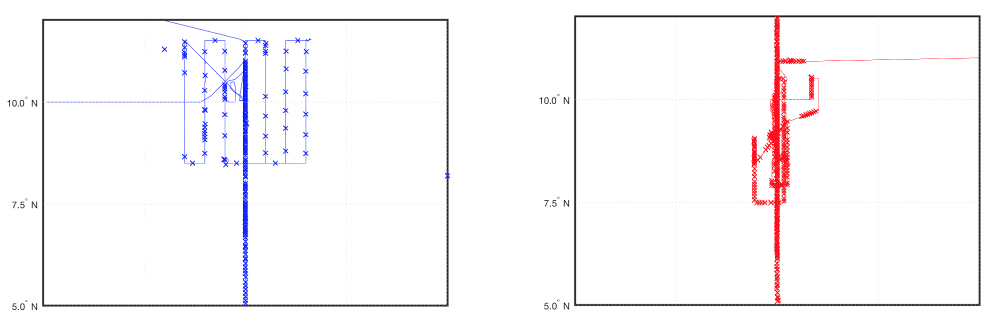


Figure 3.23. Locations of uCTD casts (x's) on (left) cruise 1 and (right) cruise 2. Light line in each figure is the Revelle track.

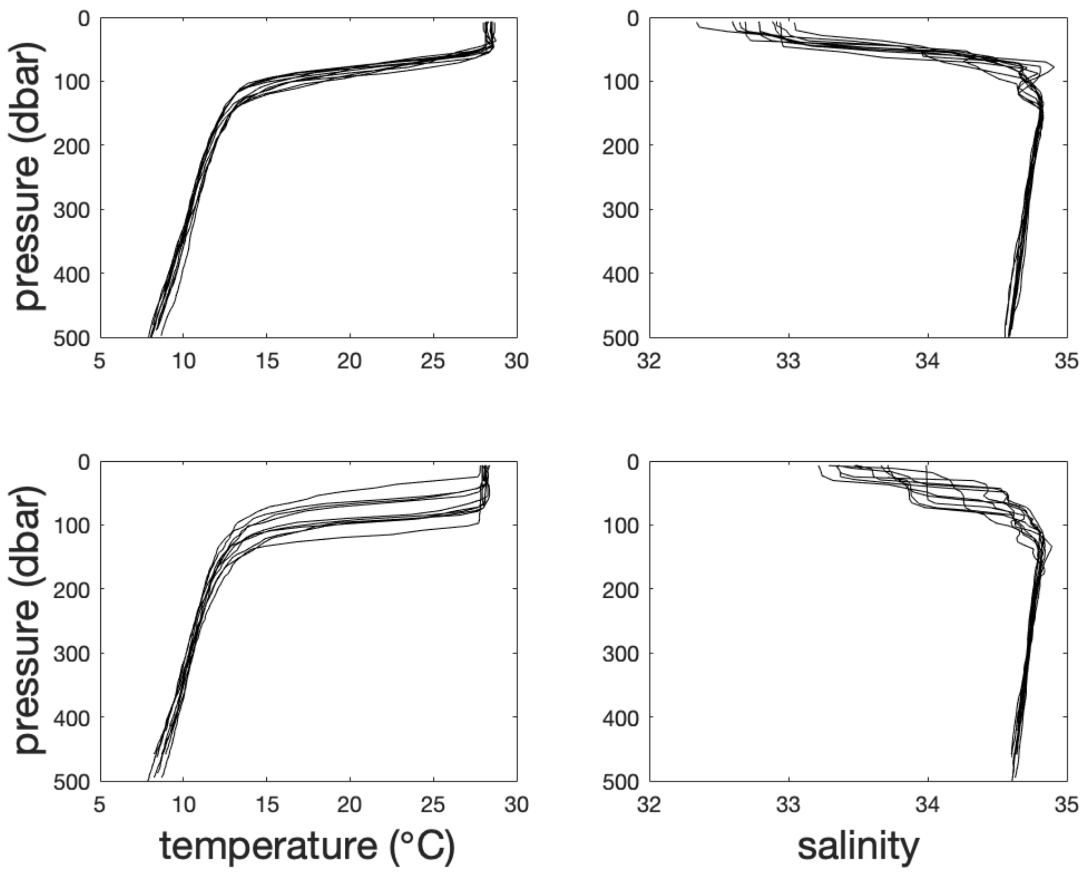


Figure 3.24. Ten random profiles from each Revelle cruise. Left column: temperature. Right column: salinity. Top row: cruise 1. Bottom row: cruise 2.

3.2.2 SSP data

dx.doi.org/10.5067/SPUR2-SSP00

The surface salinity profiler (SSP) was a towed instrument that included a salinity intake at the surface and CTDs at a set of three shallow depths (Drushka et al., 2019; Asher et al., 2014). It also had two microstructure probes. It was mounted on a sailboard-like platform outfitted with an outrigger for stability and a keel for in-water instrumentation (Fig. 3.27). The instrument package was towed behind the Revelle as the ship moved at approximately 4 knots. There were 18 tows on cruise 1 (Fig. 3.25) and 16 tows on cruise 2 (Fig. 3.26).

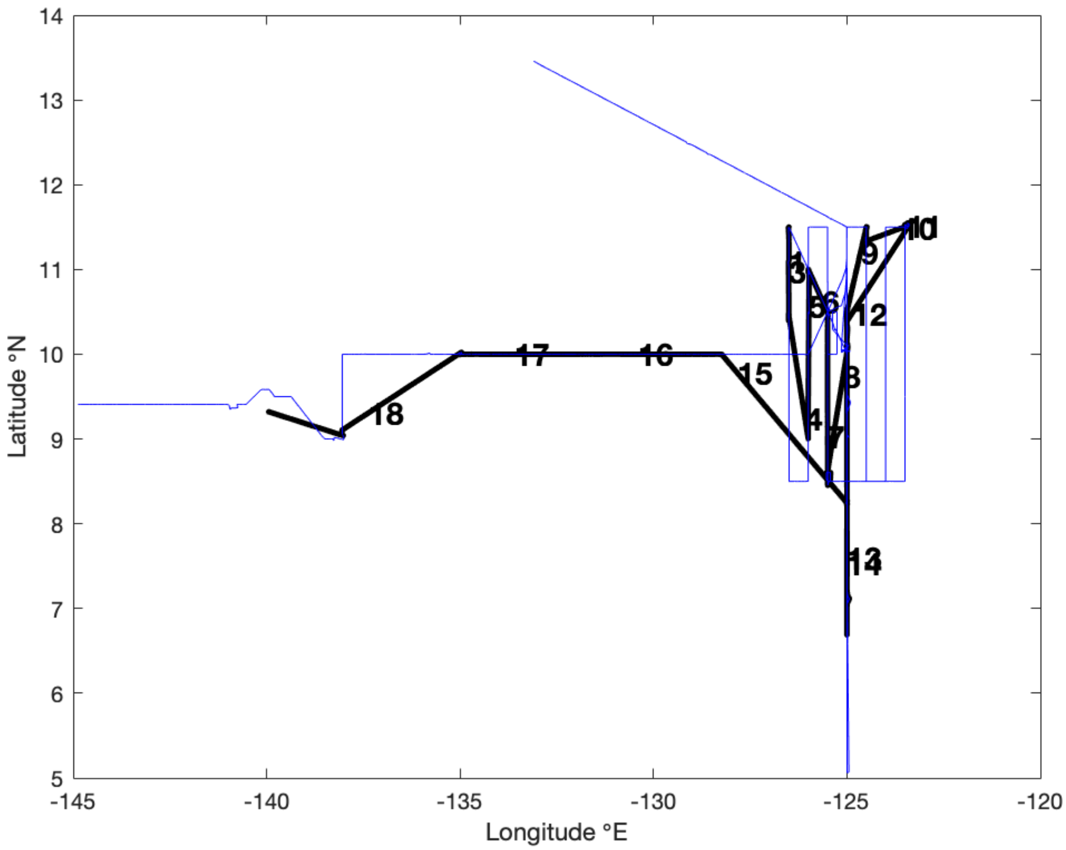


Figure 3.25. Deployment of the cruise 1 SSP tows with the ship track of Revelle shown in blue.

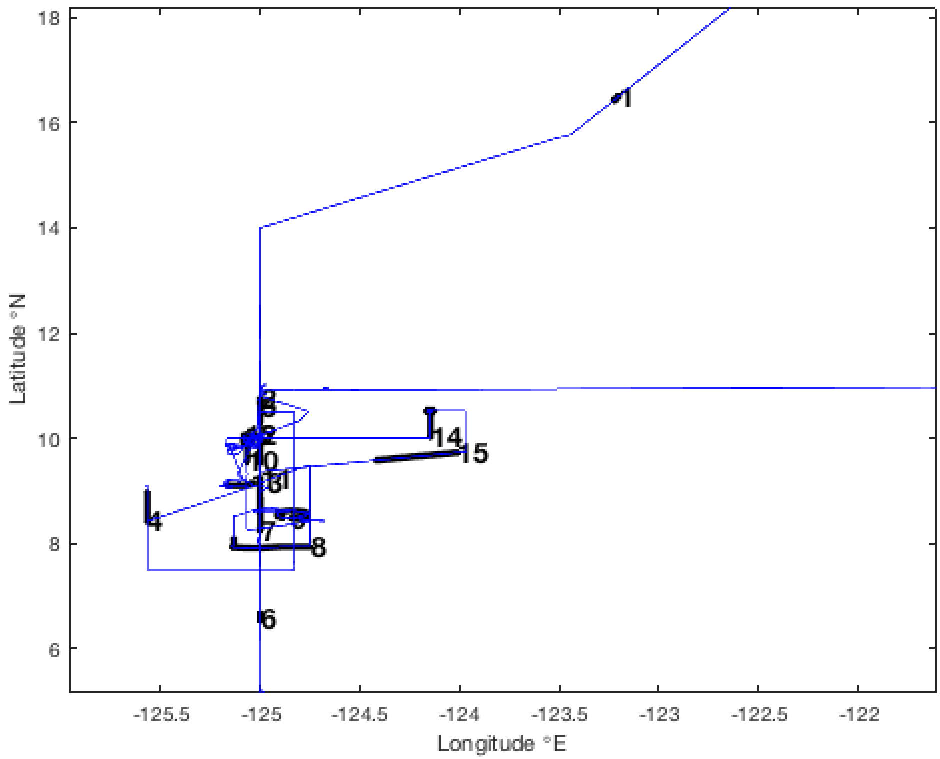


Figure 3.26. Deployment of the cruise 2 SSP tows with the ship track of Revelle shown in blue.

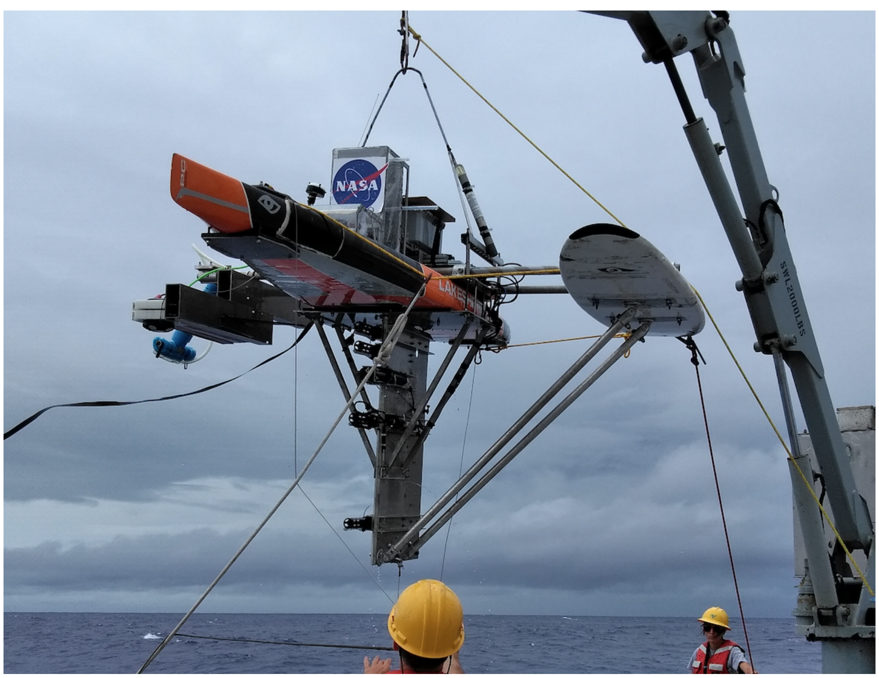


Figure 3.27. The SSP being deployed off the side of the Revelle on 30-Oct-2018. Note the keel with three CTDs on the left side and two microstructure probes on the right. The intake for the

surface salinity measurement is the light blue tube on the far left side. The plexiglass box with the “NASA” sticker houses the pump and electronics. Photo courtesy of Ben Greenwood.

3.2.3 Meteorological Data

dx.doi.org/10.5067/SPUR2-MET00

On both Revelle cruises there was a suite of meteorological instruments deployed on a mast on the bow of the ship (Fig. 3.28). These instruments measure wind speed and direction, air temperature, barometric pressure, relative humidity, precipitation, downwelling and upwelling IR, incoming and reflected solar radiation, evaporation rate, rainfall and derived heat and freshwater fluxes. Clayson et al., (2019) provide a description of the methods used to handle these data as well as some time-series plots of some of the quantities just mentioned (Fig. 3.29).

Figure 3.28. Meteorological instruments on a mast mounted on the bow of the Revelle on cruise 2. Photo courtesy of Ben Greenwood.

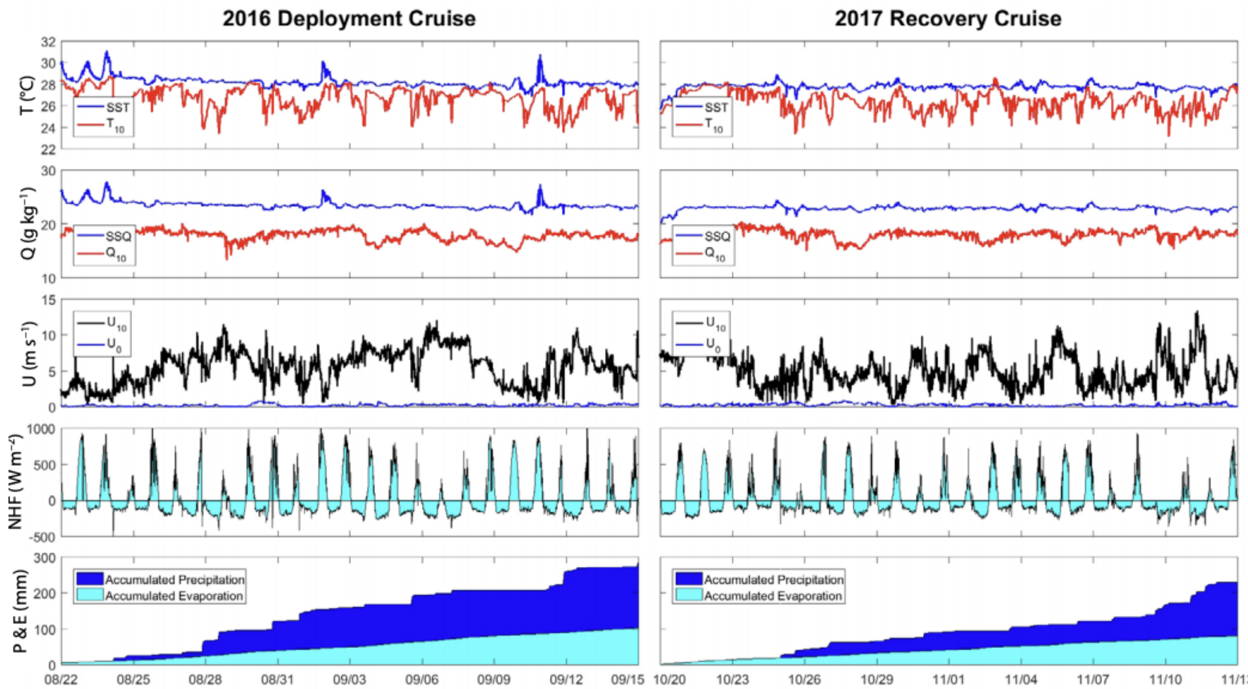


Figure 3.29. Time series of sea and air temperature, specific humidity, and wind speed (top three panels) measured during the SPURS-2 deployment (left) and recovery (right) cruises. Net heat flux (NHF) computed from the combined radiation measurements, computed sensible and latent heat fluxes, sea surface temperature, and modeled albedo is shown in the fourth panel for each cruise, with a positive value corresponding to heat input to the ocean. Measured precipitation and computed evaporation are shown as accumulations in the bottom panel for each cruise. SST and SSQ are sea surface temperature and specific humidity, respectively; U10, T10, and Q10 are wind speed, temperature, and specific humidity adjusted to 10 m, respectively; and U0 denotes the ocean current adjusted to the surface (Figure copied from Clayson et al., 2019).

3.2.4 A-sphere data

An a-sphere spectrophotometer was deployed on 25 casts during Revelle cruise 2. No final dataset is available at this time.

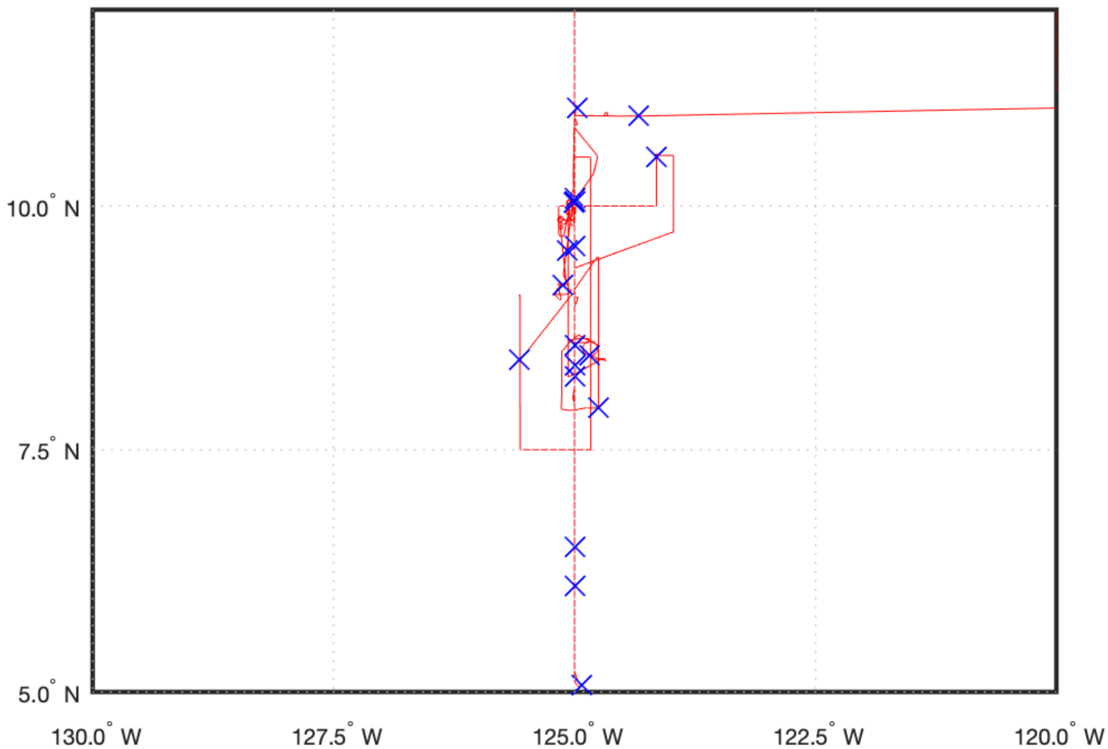


Figure 3.30. Locations of A-sphere casts (blue x's) and ship track during cruise 2 (red line).

3.2.5 Rawinsonde data

Atmospheric profile data were collected during both Revelle cruises.

3.2.5.1 Revelle cruise 1

dx.doi.org/10.5067/SPUR2-SPUR2-SONDE

Rawinsonde data from cruise 1 were collected by the WHOI group of James Edson. 82 sondes were released during the cruise (Fig. 3.31).

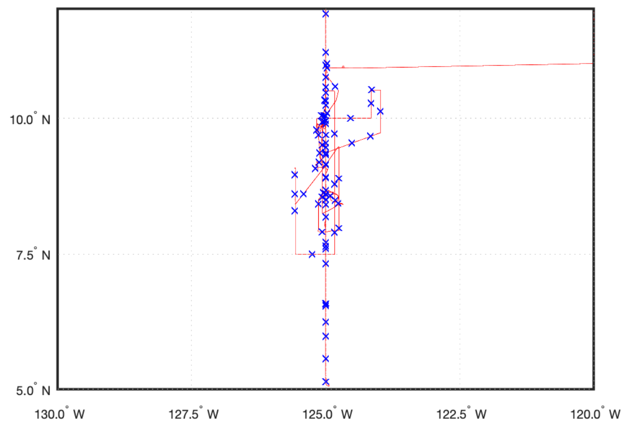


Figure 3.31. Locations of sonde releases during Revelle cruise 1.

Figure 3.32. A rawinsonde being released off the aft deck of the Revelle during cruise 2. Image courtesy of Ben Greenwood.

3.2.5.2 Revelle cruise 2

dx.doi.org/10.5067/SPUR2-SPUR2-SONDE

Rawinsonde data from cruise 2 were collected by the CSU group of Steve Rutledge. 79 sondes were released during the cruise (Fig. 3.33). A processing and QC document is available at the PO.DAAC archive web page.

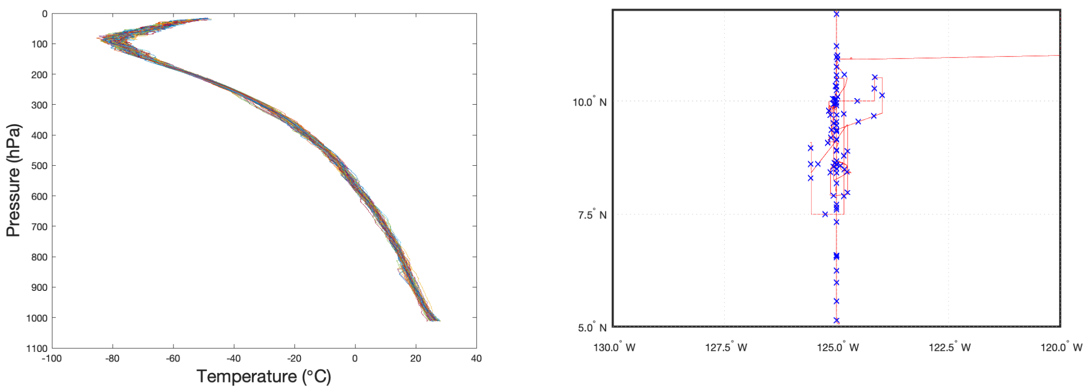


Figure 3.33. Left: Ensemble of sonde-measured temperature profiles during Revelle cruise 2. Right: Locations of sonde releases during Revelle cruise 2 (blue x's) and the ship track (red line).

3.2.6 Salinity snake data

dx.doi.org/10.5067/SPUR2-SNAKE

The salinity snake collects water from the top couple of centimeters of the surface while the ship is underway, pumps it through a series of debubblers, and then into a TSG. It runs in two different modes, one while the ship is going fast (~10 knots) and another when the ship is going more slowly. It automatically switches between modes. See Schanze et al. (2014) for details.

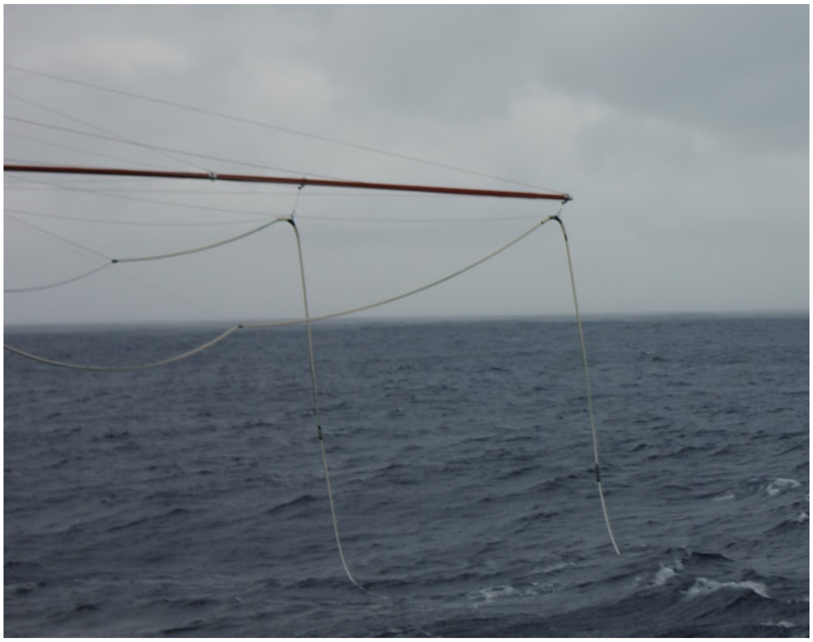


Figure 3.34. Salinity snake deployed from a boom off the starboard bow of the Revelle. Note the two intake hoses, one for fast motion and the other for slow. Image courtesy of University of Washington Applied Physics Laboratory.

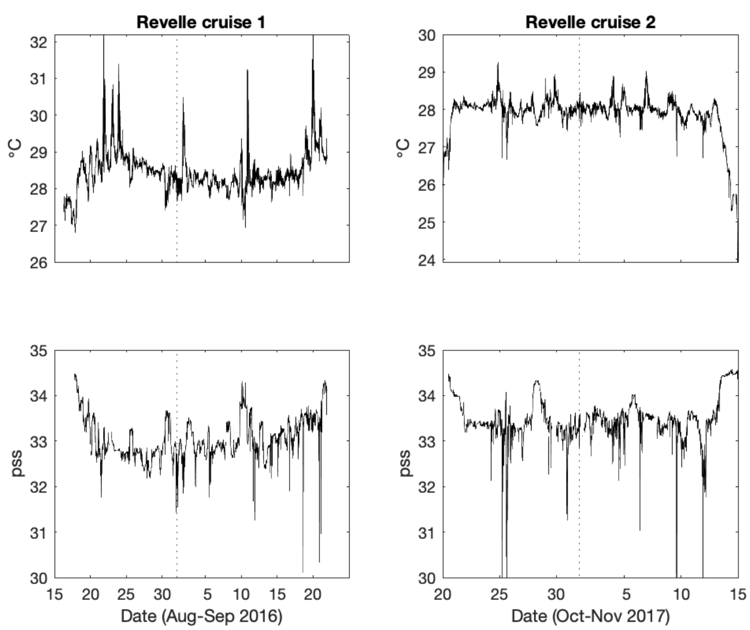


Figure 3.35. Along-track time series from the salinity snake for (left column / right column) Revelle cruise 1 / 2. Top row: temperature. Bottom row: salinity.

3.2.7 ROSR data

dx.doi.org/10.5067/SPUR2-SPUR2-ROSR0

ROSR data were collected on Revelle cruise 1. No final dataset is available at this time.

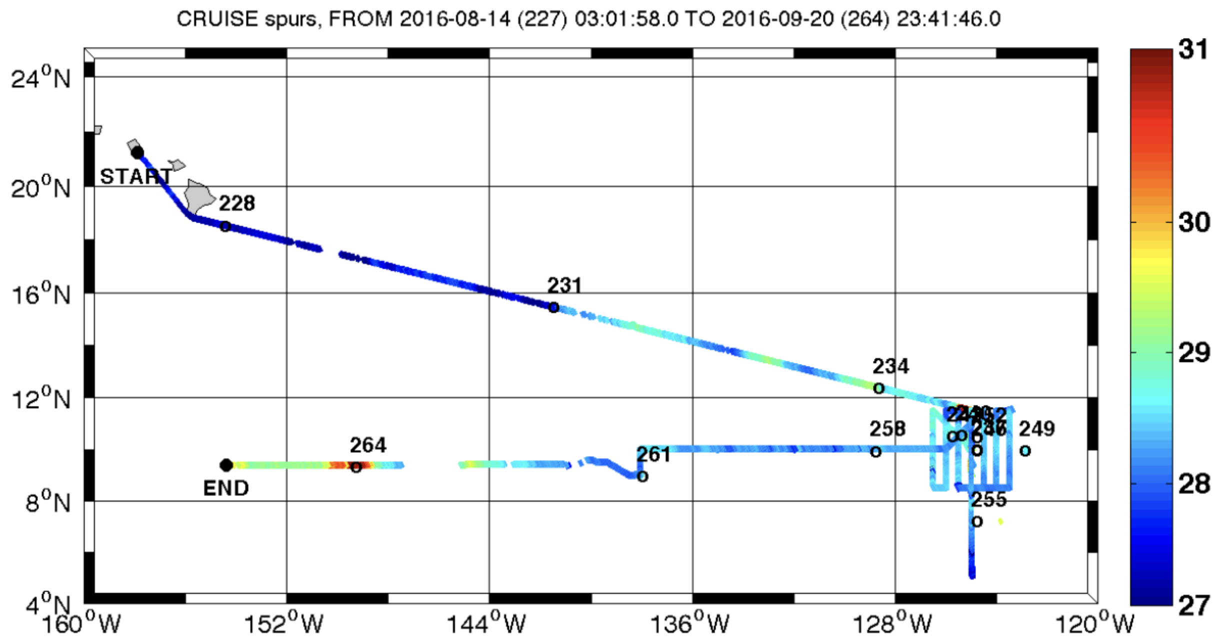


Figure 3.36. Trackline showing skin temperature and with year days noted. Figure taken from Jessup et al. (2016).

3.2.8 ACFT data

dx.doi.org/10.5067/SPUR2-SPUR2-CFT00

Turbulence in the upper centimeter of the ocean was measured on both Revelle cruises using the active controlled flux technique. See Asher et al. (2019) for details on the technique and description of the cruise 1 data.

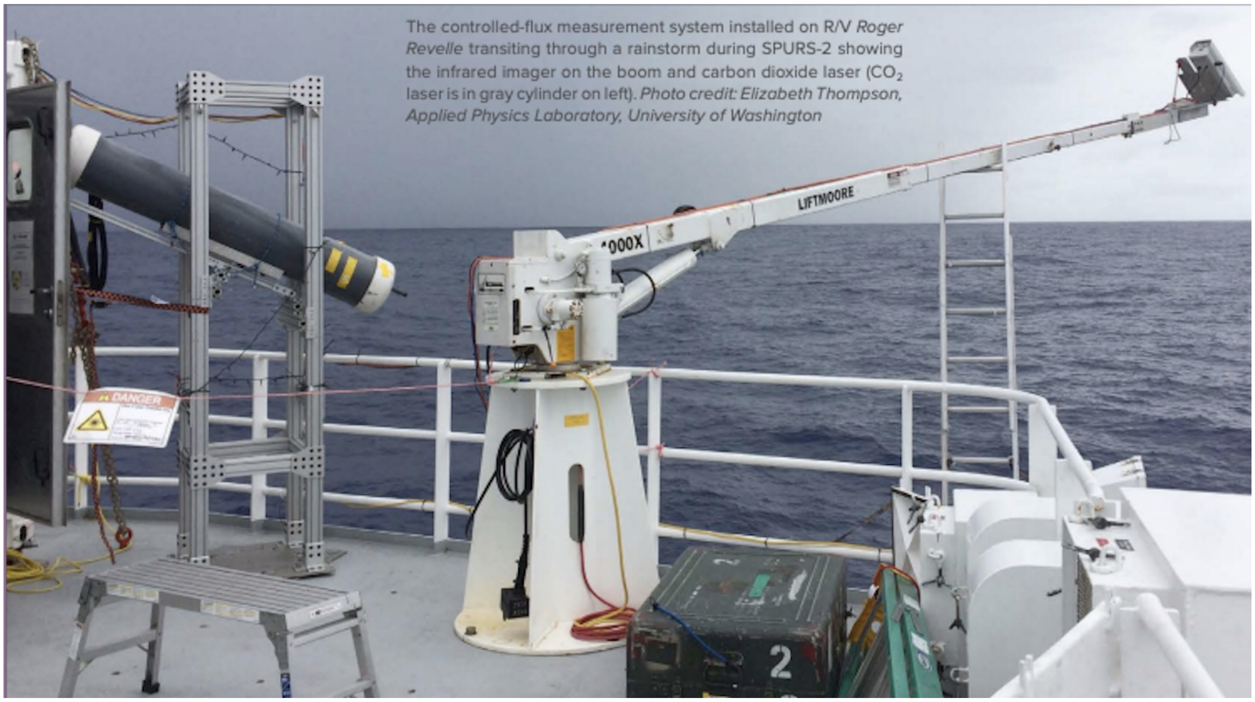


Figure 3.37. The controlled-flux measurement system installed on R/V Roger Revelle. Photo taken from Asher et al. (2019).

3.2.9 Underway geochemistry data

dx.doi.org/10.5067/SPUR2-SPUR2-PCO20

Underway geochemistry data (pCO_2, DIC, pH and DO_2) were collected on both Revelle cruises. No final dataset is available at this time.

3.2.10 Ecomapper data

dx.doi.org/10.5067/SPUR2-ECOMP

An EcoMapper carrying a suite of instrumentation was deployed on two missions during the Revelle cruise 2 drifter experiment on 30 and 31-Oct 2017. No final dataset is available at this time. We show the trajectories below.

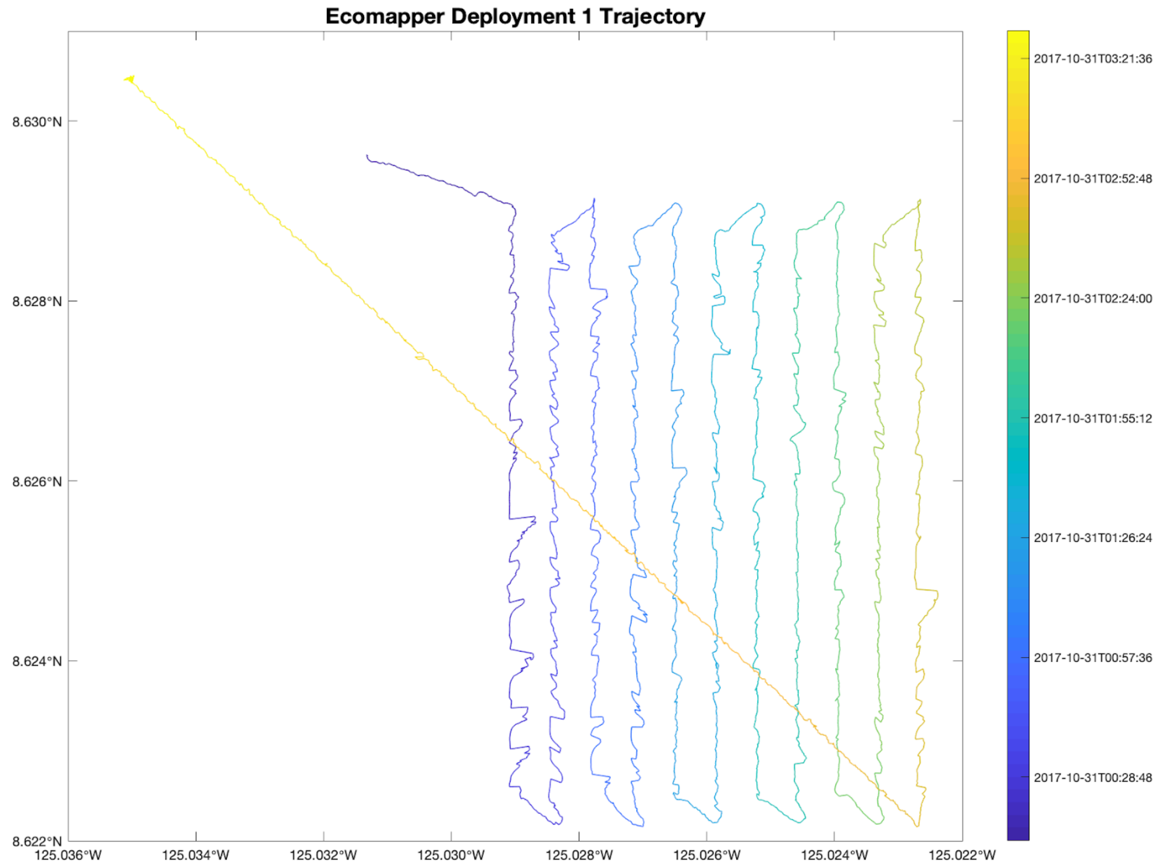


Figure 3.38. Trajectory of the first EcoMapper deployment during the Revelle cruise 2.

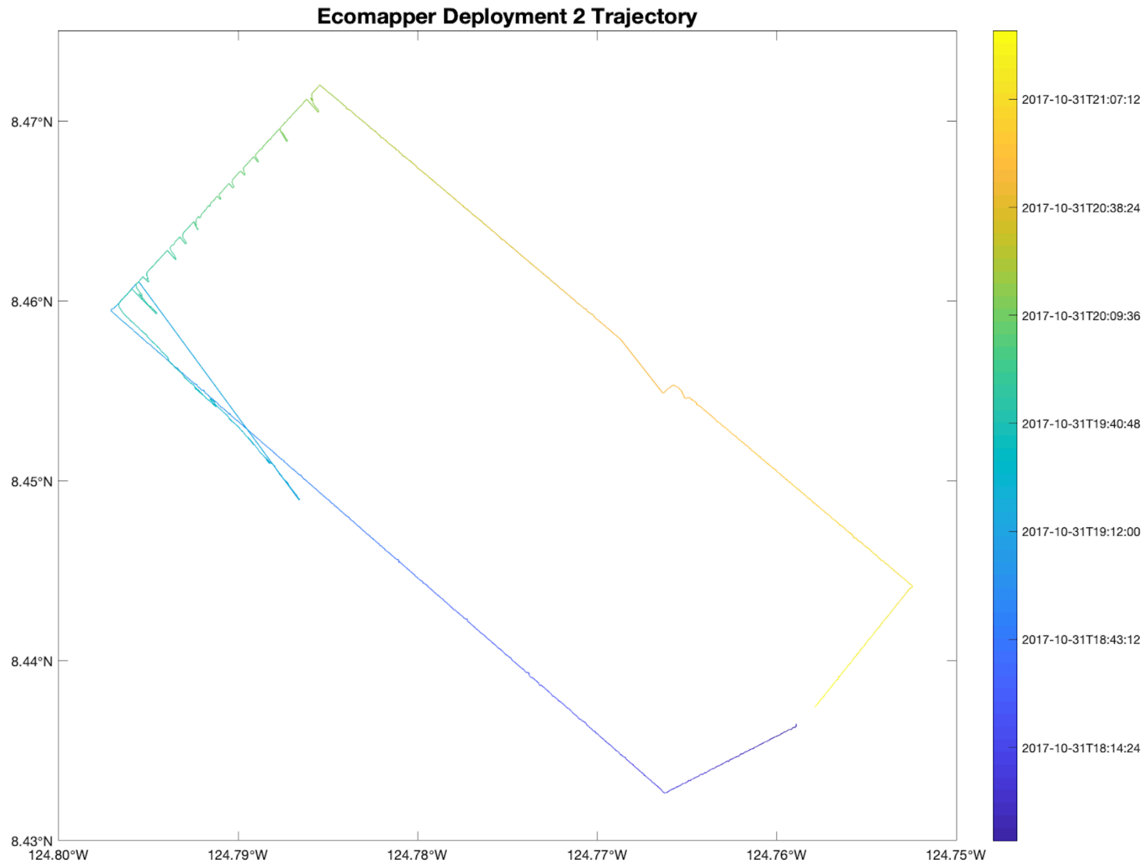


Figure 3.39. Trajectory of the second EcoMapper deployment during the Revelle cruise 2.

Figure 3.40. EcoMapper being deployed from R/V Roger Revelle. Photo courtesy of Spencer Kawamoto.

3.2.11 Underway biology

dx.doi.org/10.5067/SPUR2-SPUR2-BIOPT

Underway optical and phytoplankton data were collected during Revelle cruise 2. No final dataset is available at this time.

3.2.12 SEA-POL Radar

dx.doi.org/10.5067/SPUR2-RNRDR

On the second Revelle cruise, the group from Colorado State deployed a long-range radar for measuring rain. The SEA-POL is a C-band doppler polarimetric radar (Rutledge et al., 2019). The radome was deployed on the bow of the ship, just in front of the bridge (Fig. 3.41). The instrument was operating between 22-October and 11-November-2017 (Fig. 3.42). Estimates of rain rate, rain age and 30 and 60-minute accumulation were produced approximately every 5 minutes along the track of the ship. These 5-minute maps were produced on a 301X301 grid whose elements were about 1.4 km apart. Thus, rainfall estimates were obtained over a 420kmX420km box with the ship at the center every 5 minutes. Note, the placement of the radome in front of the bridge meant that the rainfall estimates were blanked out over about an 80° angle looking aft.

Figure 3.41. The Revelle in port in San Diego prior to cruise 2. The SEA-POL radar is the large "golf ball" radome placed in front of the bridge on the 02 deck.

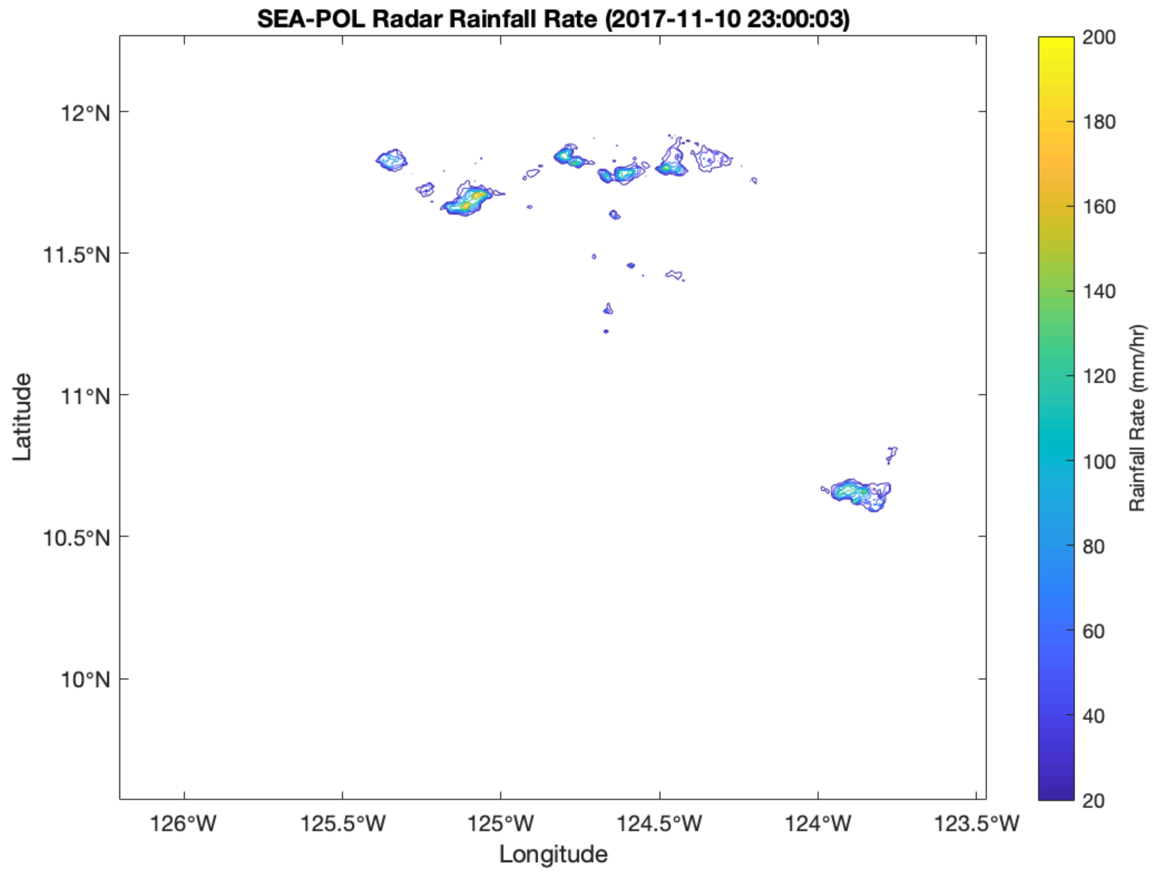


Figure 3.42. Contour of the rainfall rate on 2017-11-10 at 23:00:03 from the SEA-POL radar.

3.2.13 X-Band radar rain imagery

dx.doi.org/10.5067/SPUR2-SPUR2-XBAND

A commercial X-band radar was used to infer rainfall. It operated in this mode for the entirety of cruise 1 and while the Revelle was steaming at full speed during cruise 2, about ⅔ of the cruise. On the second cruise, when the ship was going at less than full speed, the X-band radar was turned to wave mode (section 3.2.15). Details of the operation of the system are given by Thompson et al. (2019).

Figure 3.43. The mast of the Revelle, and the SEA-POL radar. The X-band radar is circled. Image courtesy of E. Thompson.

3.2.14 Cruise 2 Synthesis Rain Product

dx.doi.org/10.5067/SPUR2-SPUR2-SYNTH0

No such synthesis product has been produced at this time.

3.2.15 Cruise 2 WAMOS Wave Radar

dx.doi.org/10.5067/SPUR2-WAMOS

During cruise 2, the Revelle collected directional wave data from a WAMOS wave radar instrument when the SSP was deployed, i.e. when the ship was moving slowly (~< 5 knots). These data encompassed standard surface wave information such as peak period, primary and secondary swell direction, etc. See section 3.2.13 for a picture of the radar instrument. It was the same one that collected the X-band rainfall data.

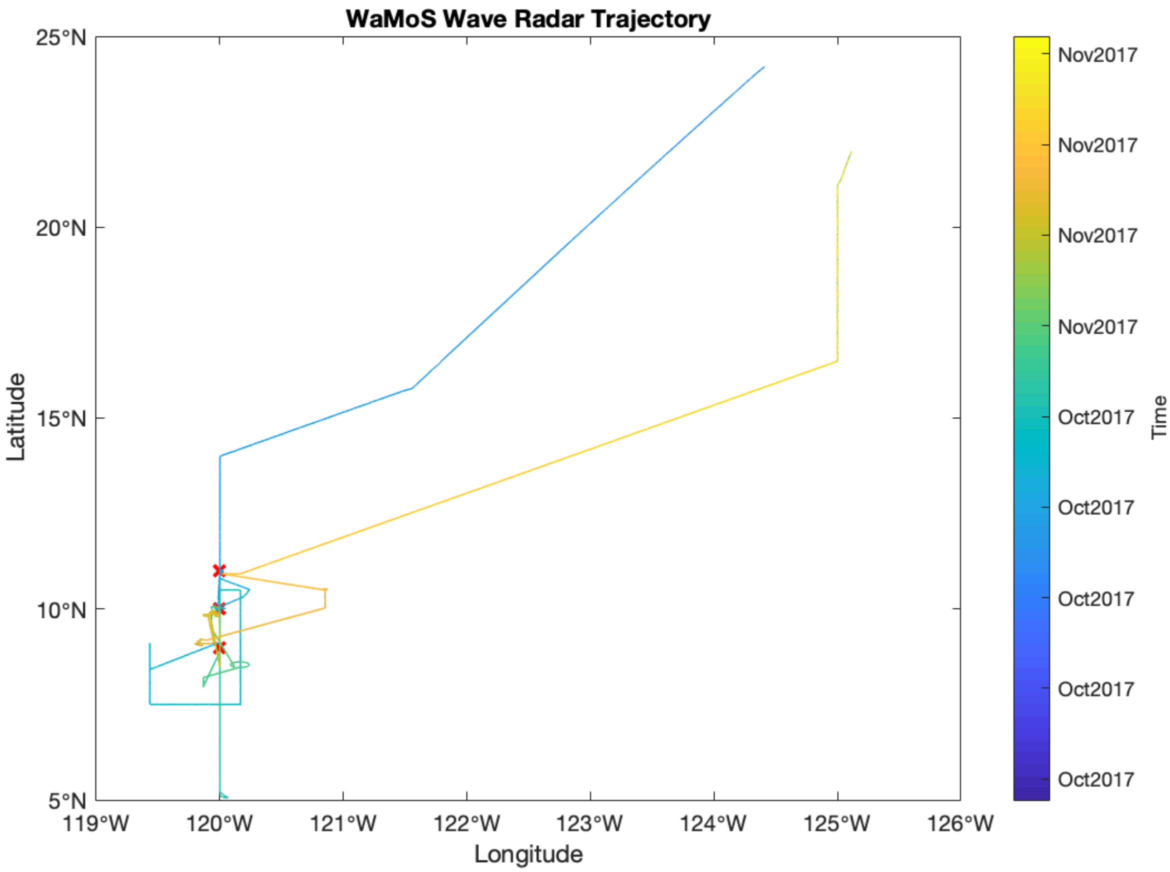


Figure 3.44. Trajectory of WAMOS wave radar instrument during cruise 2 of the R/V Roger Revelle.

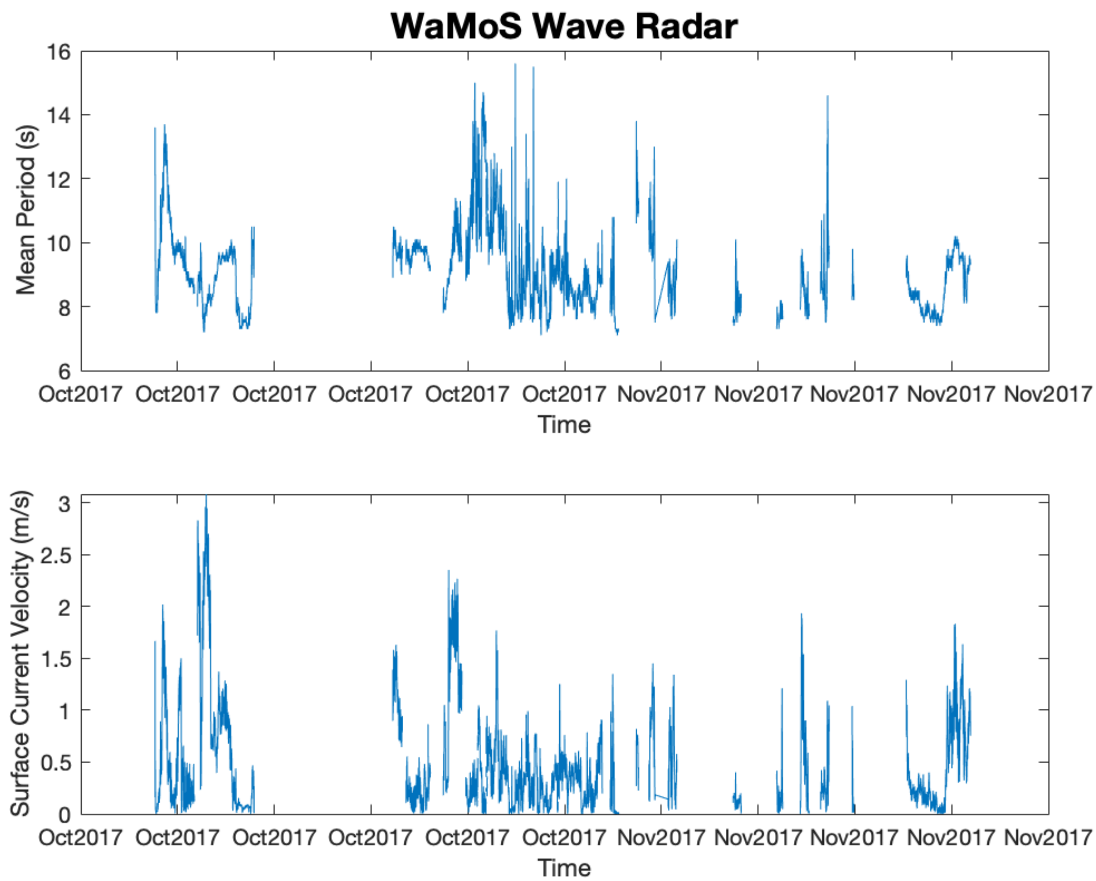


Figure 3.45. Sea surface swell wave mean period and surface current velocity from WAMOS Wave Radar.

3.3 Mooring data

There were three moorings deployed during SPURS-2, the "central mooring" and two "PICO" or prawler moorings.

3.3.1 Central mooring

dx.doi.org/10.5067/SPUR2-MOOR1

The WHOI-UOP Surface Mooring deployed at 10°N, 125°W within the SPURS site in August 2016 collected data until November 2017. Multiple instruments collected data from the central mooring: Rotronic MP-101A, Heise DXD, Eppley Laboratory, INC. Precision Infrared Radiometer and Precision Spectral Pyranometer, R.M. Young 50202 Precipitation Gauge and 5103 Wind Monitor, and Seabird Electronics 37-SM. Meteorological variables include air temperature, relative humidity, air pressure, surface downwelling shortwave and longwave radiation, rainfall, eastward and northward winds, sea water temperature, sea water salinity, and sea water conductivity. Surface fluxes calculated with Coare 3.0 algorithm from surface mooring data include surface downward sensible and latent heat fluxes, downward net heat flux, and surface net downward shortwave and longwave fluxes. In-situ measurements include sea water temperature, sea water salinity, and sea water conductivity. Other variables from instruments at the central mooring: sea surface skin temperature, wind stress magnitude and direction, wind speed and direction relative to currents, and specific humidity. See Jessup (2016) for a diagram of the mooring and a complete list of the instruments deployed on the mooring line.

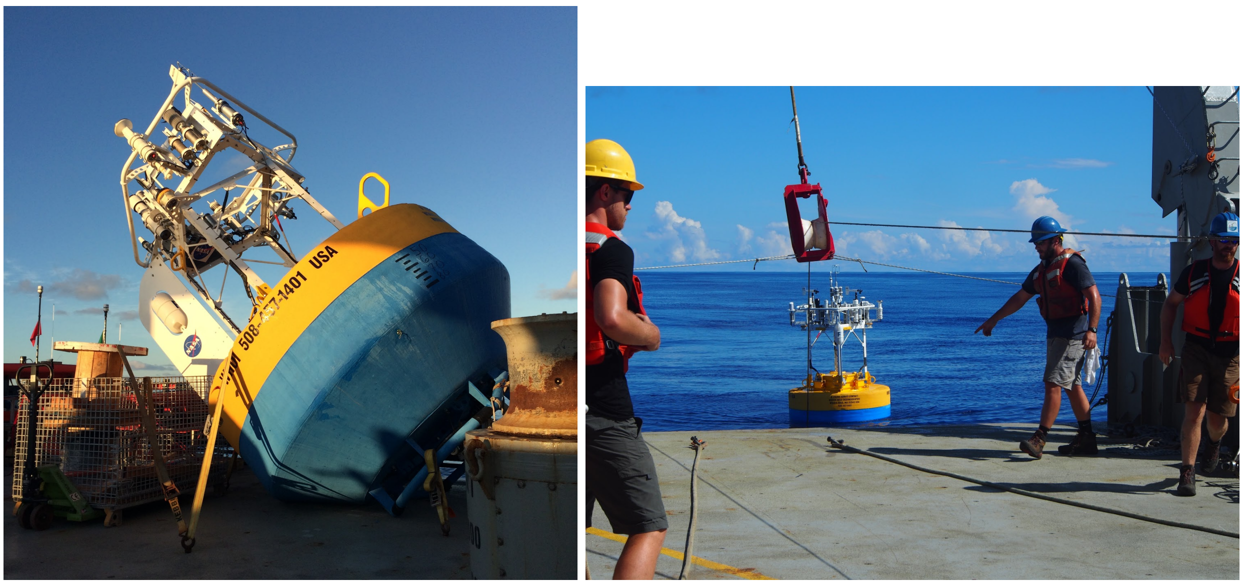


Figure 3.46. Central mooring onboard Revelle during cruise 2 (left). Central mooring being deployed from Revelle into the Pacific Ocean during cruise 2 (right).

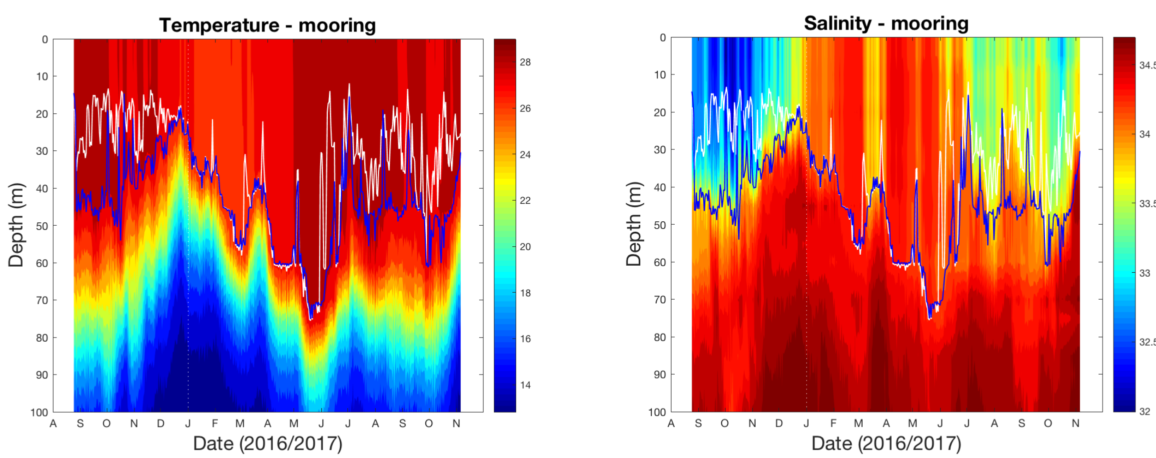


Figure 3.47. Contour of temperature through depth and time (left). Contour of salinity through depth and time (right). Blue line is the temperature-defined mixed-layer depth. White line is the salinity-defined mixed-layer depth. The difference between them is the barrier-layer thickness (de Boyer Montégut et al. 2007)

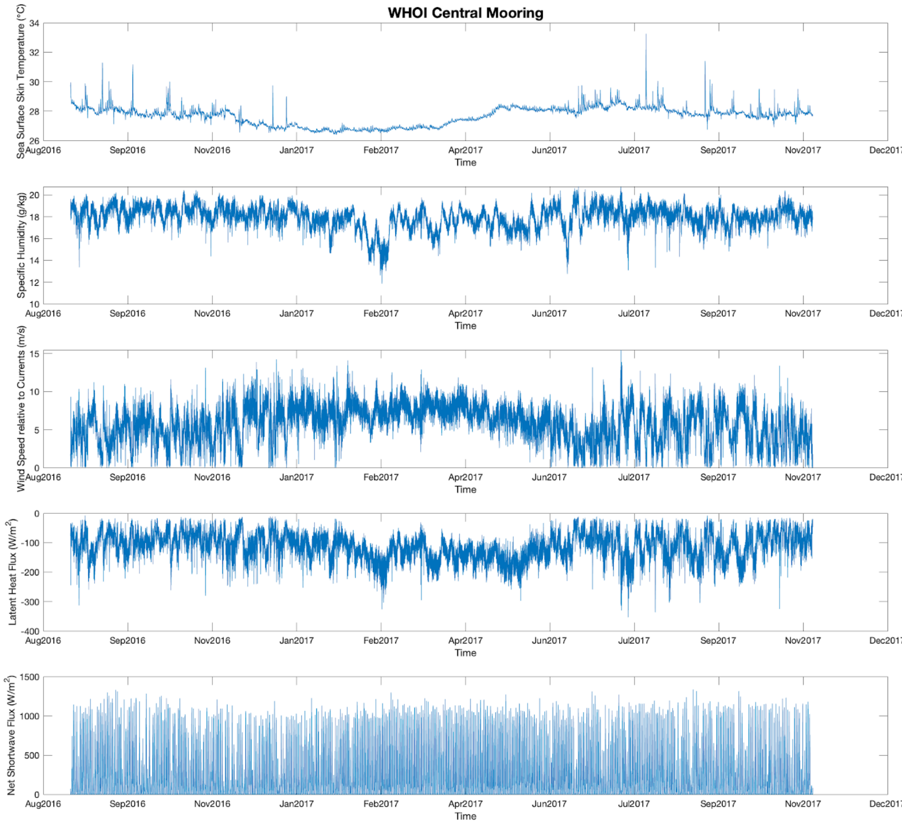


Figure 3.48. Data from the WHOI central mooring. Top to bottom: Sea Surface Temperature adjusted to skin. Wind speed relative to currents. Specific humidity. Latent heat flux. Net shortwave flux.

3.3.2 PICO moorings

dx.doi.org/10.5067/SPUR2-MOOR2

Two PICO moorings collected CTD data during the SPURS-2 project. PICOSP01 was located at 11°N, 125°W and recorded data from 2016-Aug-25 at 17:22 until 2017-Jul-03 at 12:46 down to a depth of 466.15 meters. PICOSP02 was located at 9.05°N, 125°W and recorded data from 2016-Aug-22 at 18:02 until 2017-Oct-12 at 12:15 down to a depth of 546 meters. See Jessup (2016) for a diagram of the moorings.

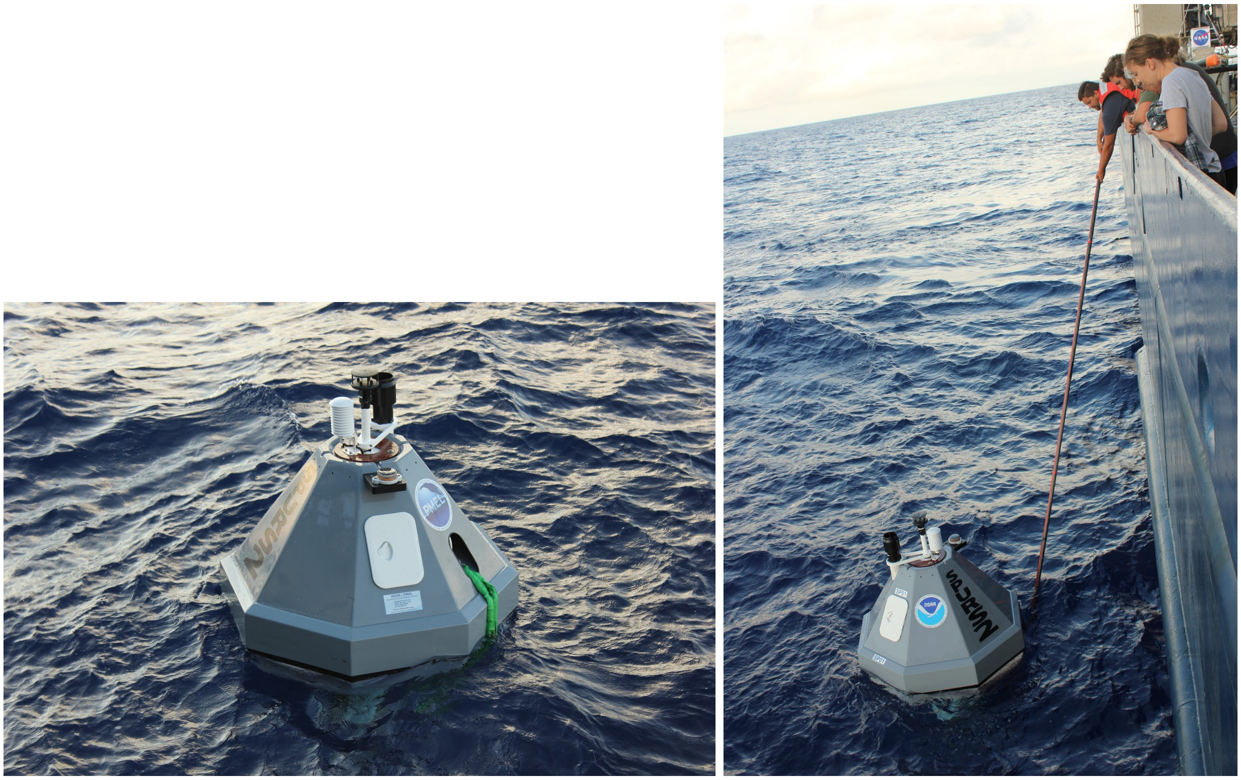


Figure 3.49. Retrieval of PICO mooring from R/V Roger Revelle. Photo courtesy of A. Jessup.

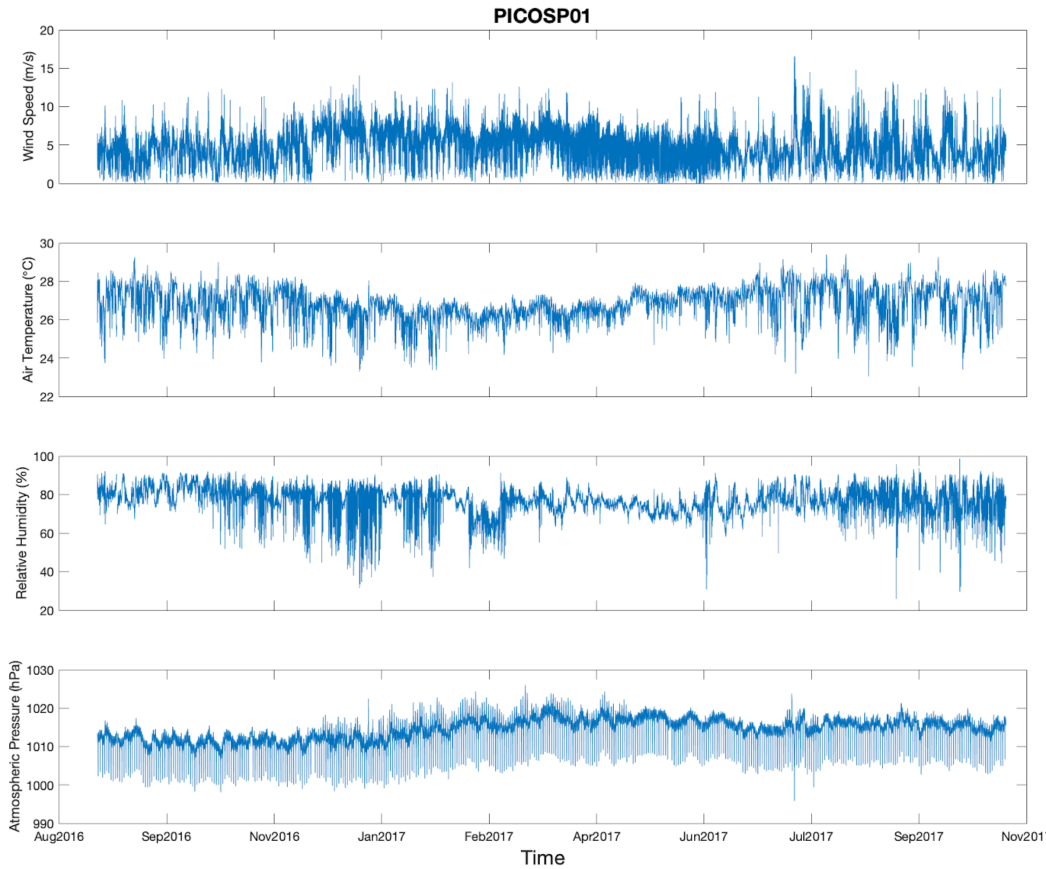


Figure 3.50. Wind speed, air temperature, relative humidity, and atmospheric pressure collected from the PICOSP01 mooring.

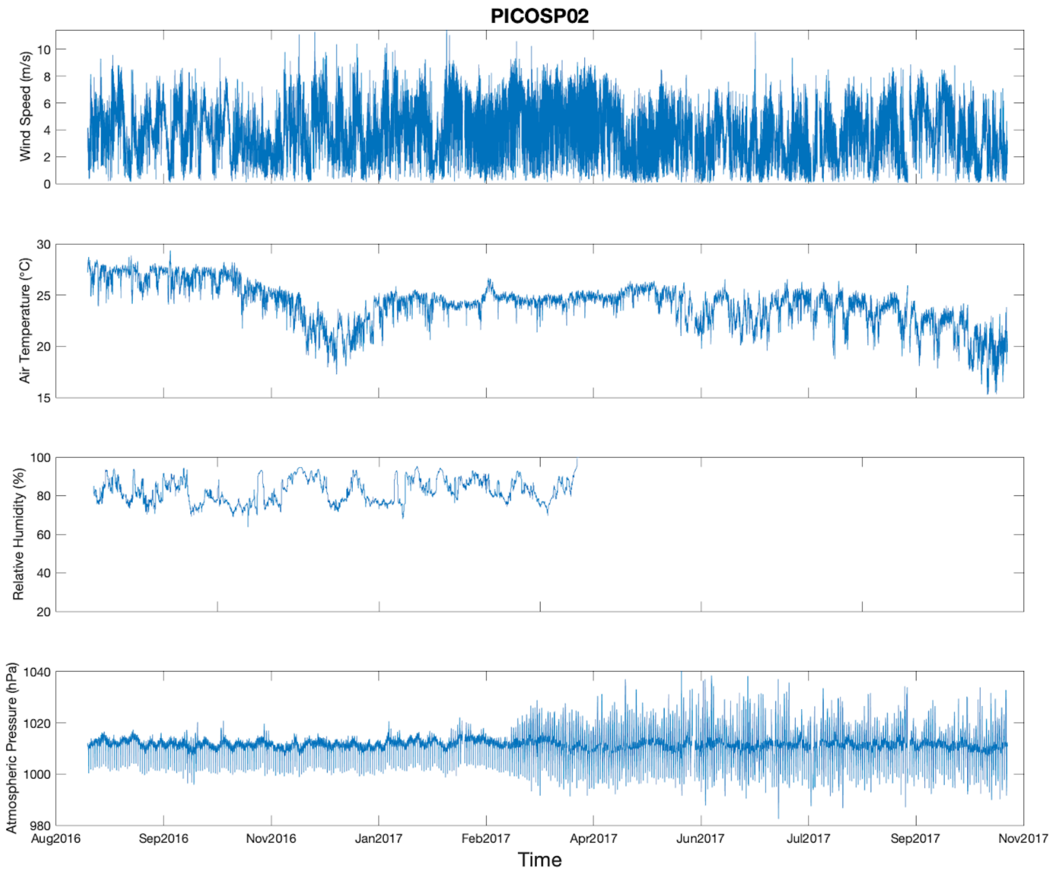


Figure 3.51. Wind speed, air temperature, relative humidity, and atmospheric pressure collected from the PICOSP02 mooring.

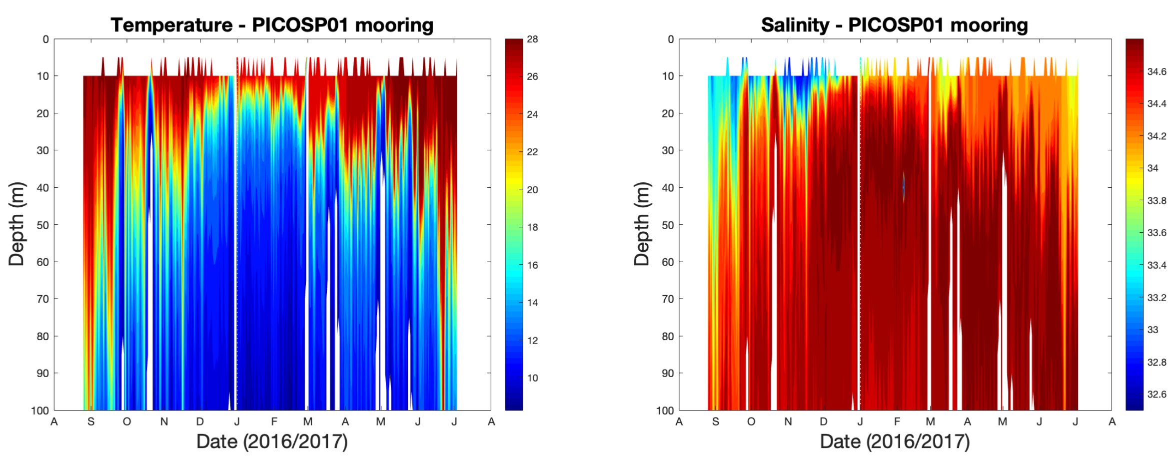


Figure 3.52. PICOSP01 - Contour of temperature through depth and time (left). Contour of salinity through depth and time (right).

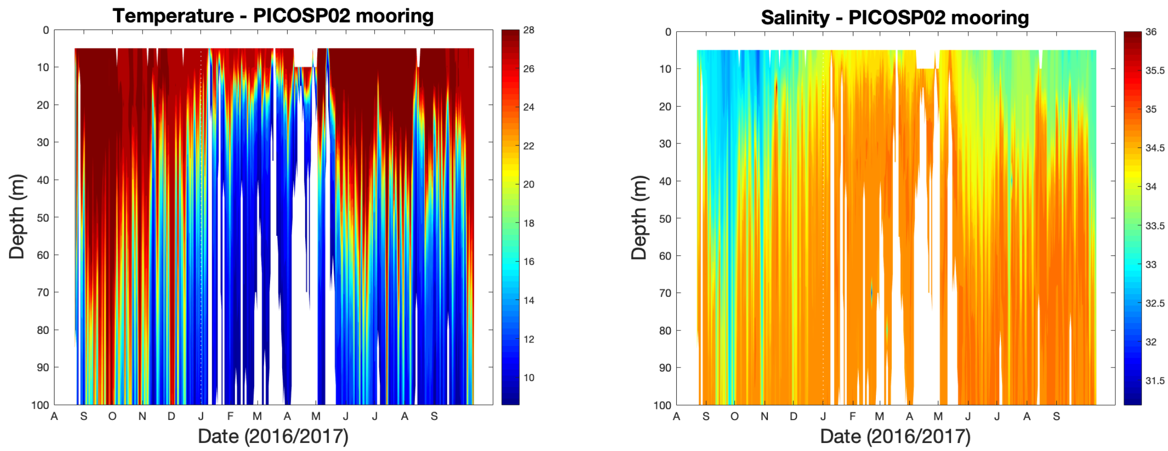


Figure 3.53. PICOSP02 - Contour of temperature through depth and time (left). Contour of salinity through depth and time (right).

3.4 Lagrangian platforms

There were several forms of surface drifters deployed during SPURS-2. These included standard SVP (Surface Velocity Program) and SVP-S (SVP-salinity) drifters (Hormann et al., 2015), CODE (Coastal Ocean Dynamics Experiment) drifters, an S-ADOS drifter and SURPACT drifters. During the second Revelle cruise there was a “drifter experiment” where a set of drifters were deployed almost simultaneously within a rain event. These included CODE, SVP-S and S-ADOS drifters (Fig. 3.56).

3.4.1 SVP Drifters

dx.doi.org/10.5067/SPUR2-DRIFT

There were 59 SVP drifters and 52 SVP-S drifters deployed during SPURS-2 from the Revelle and LA.

Figure 3.54. SVP drifters being deployed from the Revelle. Photo courtesy of Audrey Hasson.

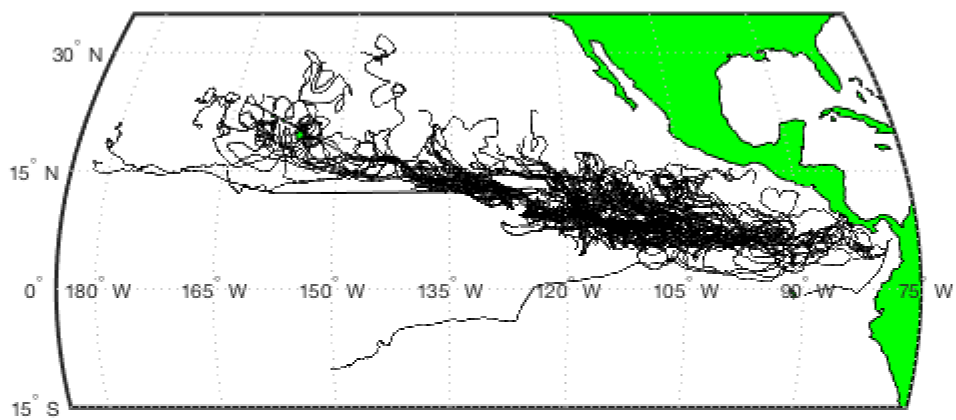


Figure 3.55. Spaghetti diagram of all of the SVP and SVP-S drifters deployed during SPURS-2 as of 19-March-2018.

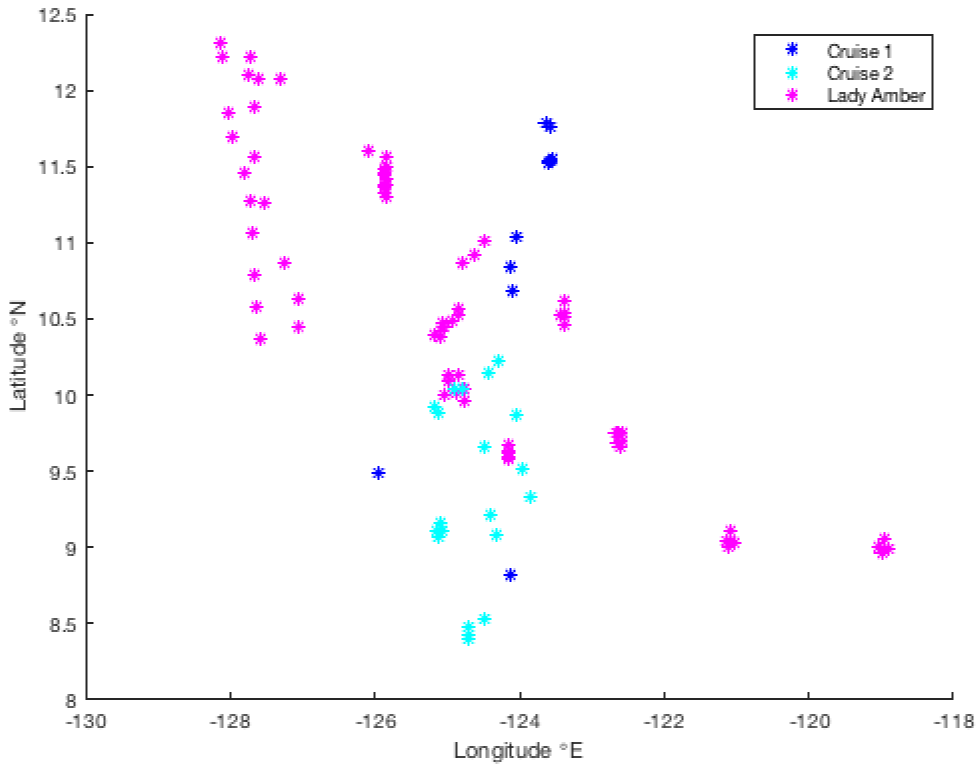


Figure 3.56. Starting locations of the SVP drifters deployed during SPURS-2. Legend indicates the ship the drifters were deployed from.

3.4.2 CODE drifters

dx.doi.org/10.5067/SPUR2-DRIFT

There were 5 CODE drifters deployed from Revelle during SPURS-2 during the cruise 2 drifter experiment (Fig. 3.58). Deployment times were on 30-Oct-2017 between 22:20 and 23:50. Recovery times were on 31-Oct-2017 between 19:45 and 22:40. CODE drifters all had CTDs on them and measured surface temperature and salinity as a function of time (Figs. 3.59-3.62). However, the CTD on CODE drifter 1 did not function properly and returned no good data.

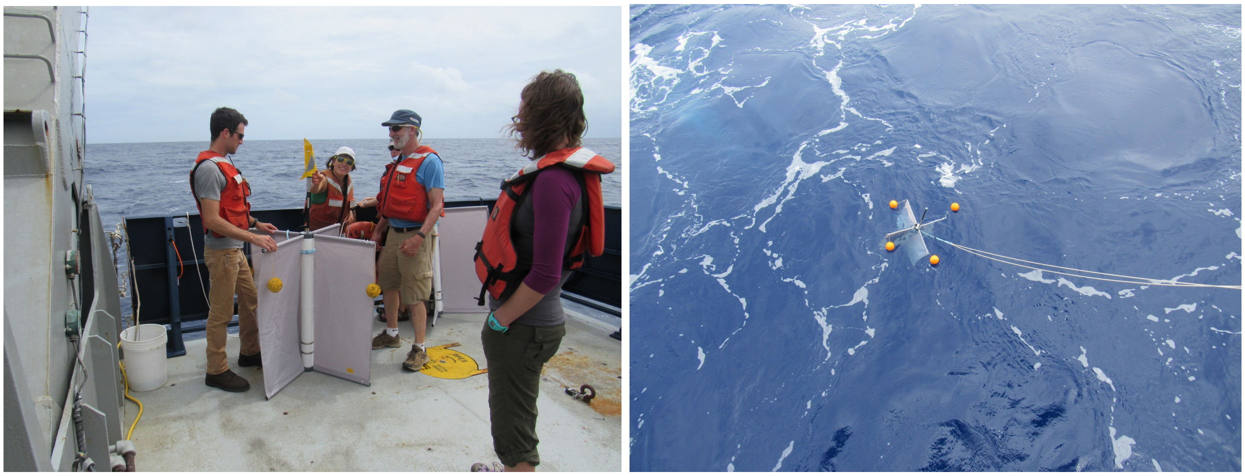


Figure 3.57. CODE drifter being deployed from R/V Roger Revelle.

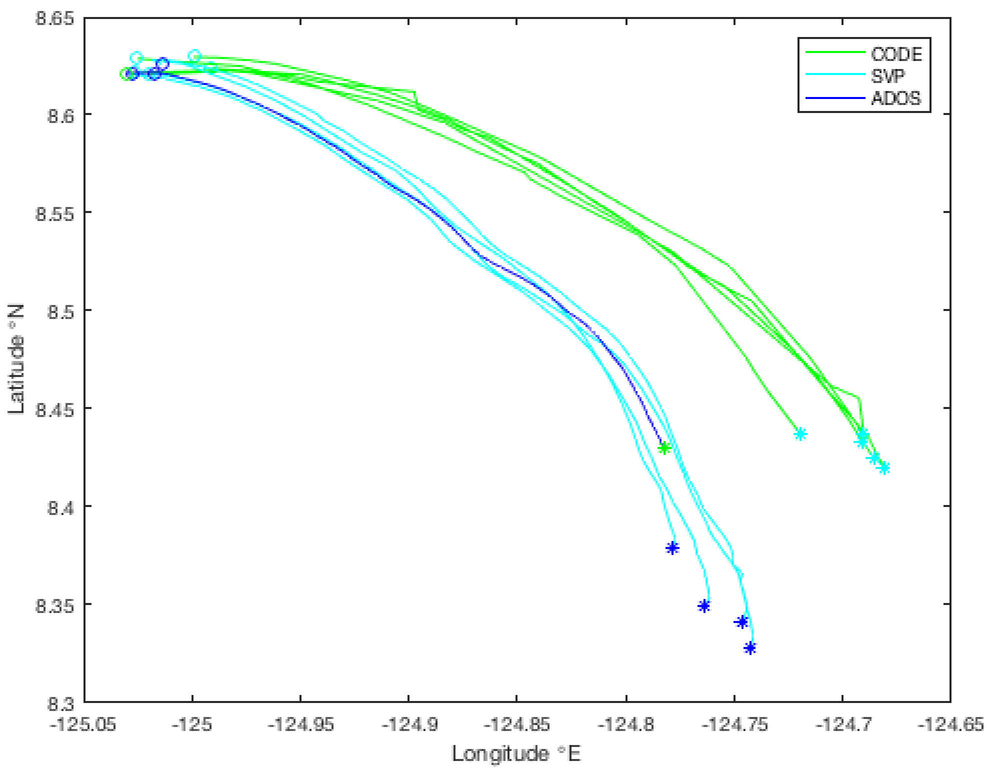


Figure 3.58. Trajectory of the CODE, S-ADOS, and SVP drifters that were deployed during the drifter experiment. The (o's) indicate the deployment and the (*'s) indicate the last recorded position for each drifter.

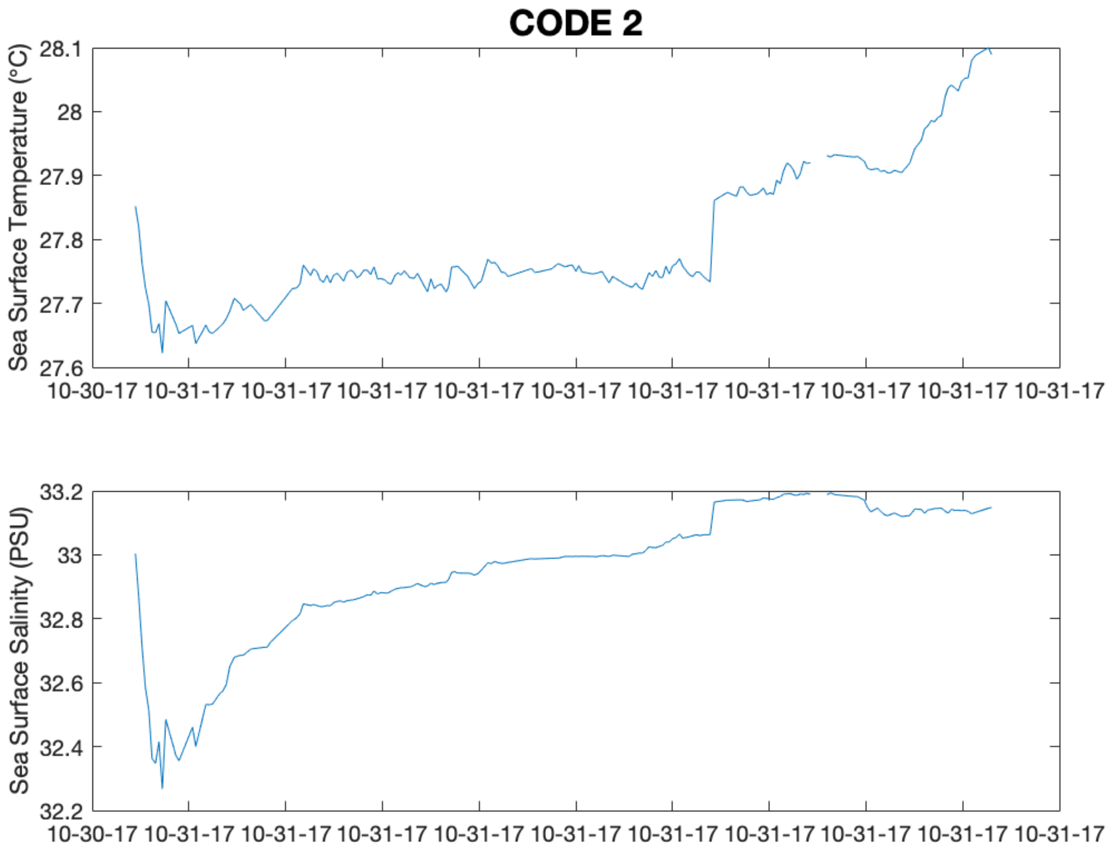


Figure 3.59. Sea surface temperature and sea surface salinity of the CODE 2 drifter.

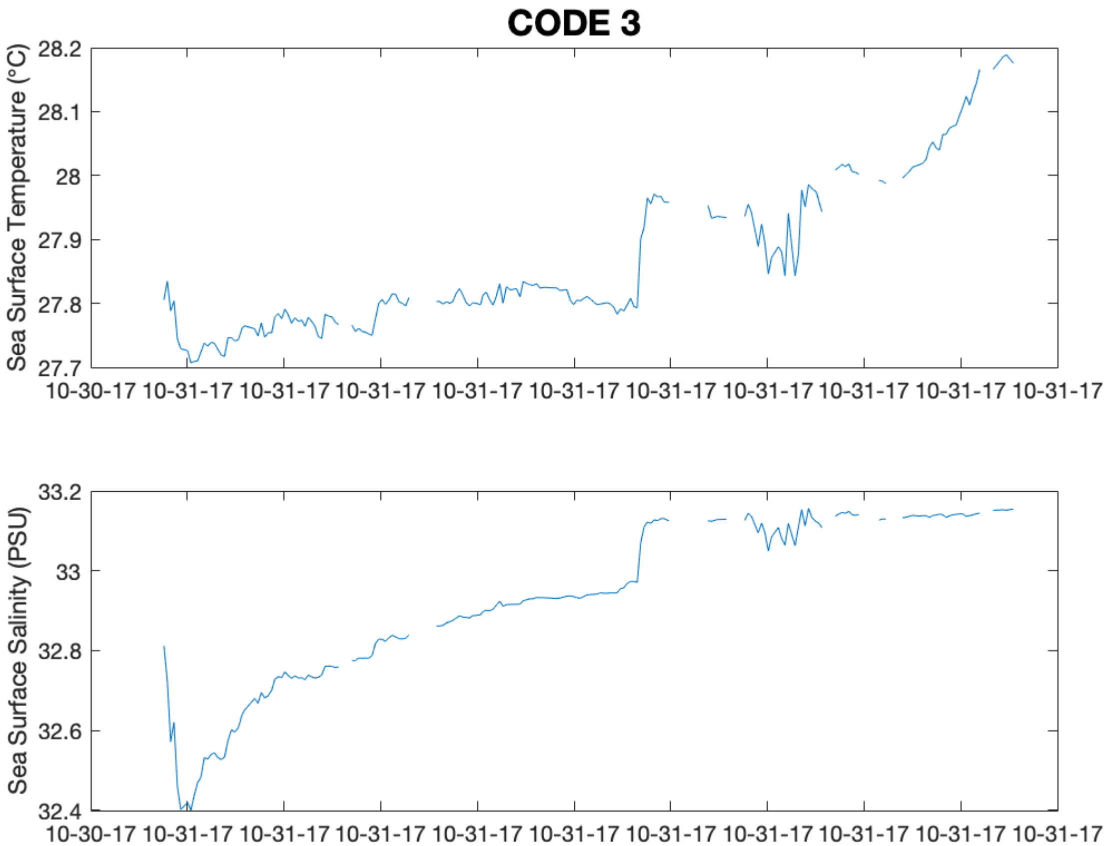


Figure 3.60. Sea surface temperature and sea surface salinity of the CODE 3 drifter.

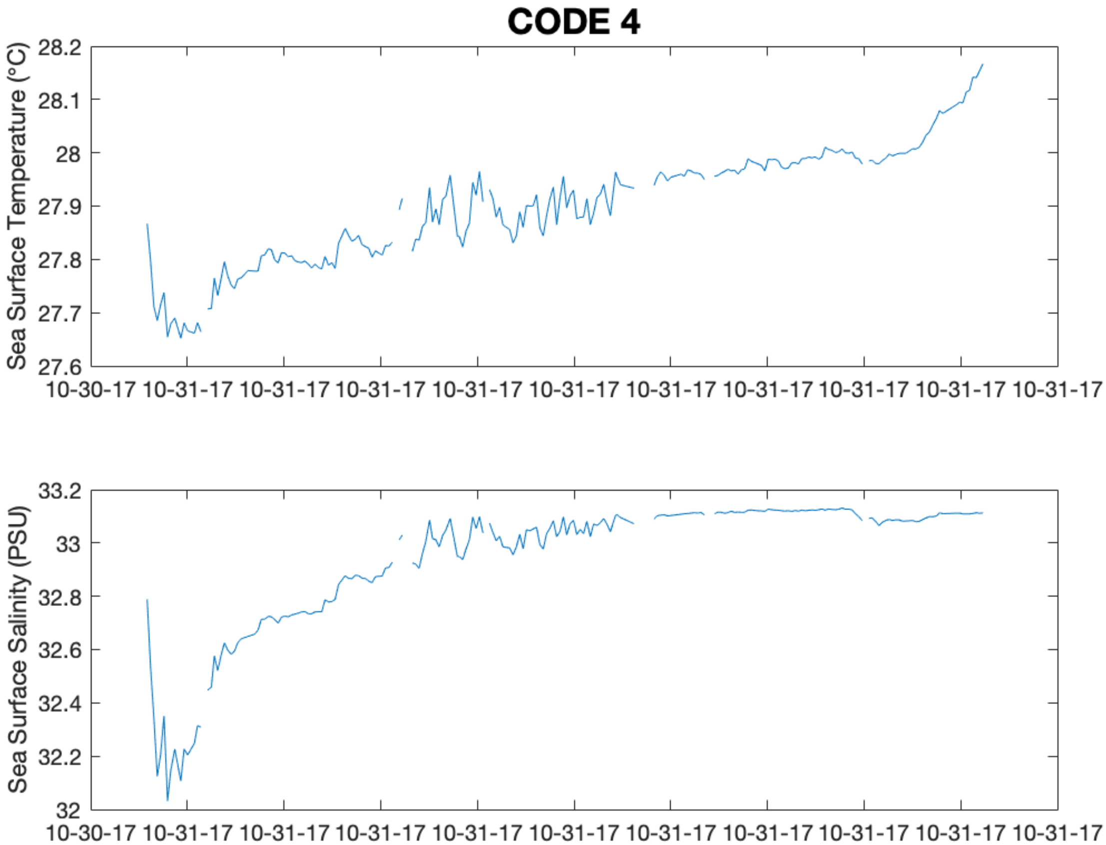


Figure 3.61. Sea surface temperature and sea surface salinity of the CODE 4 drifter.

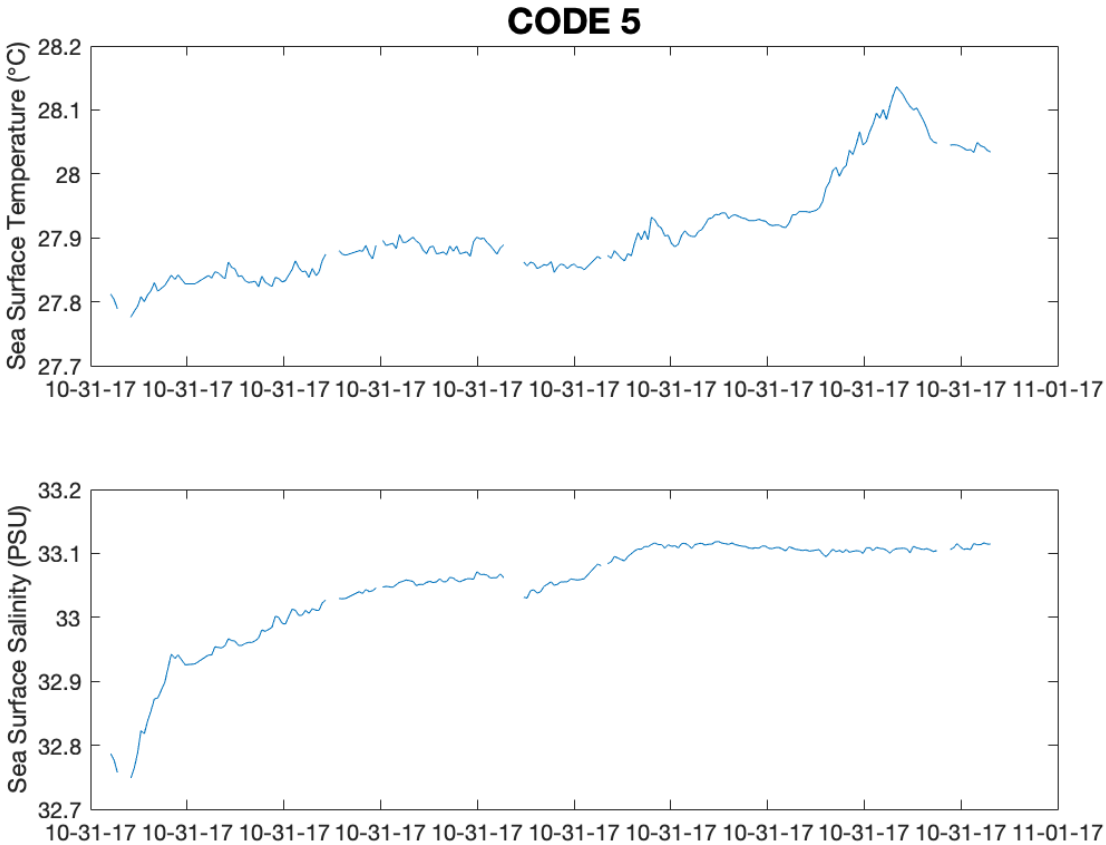


Figure 3.62. Sea surface temperature and sea surface salinity of the CODE 5 drifter.

3.4.3 S-ADOS drifter

dx.doi.org/10.5067/SPUR2-DRIFT

The S-ADOS drifter was deployed as part of the cruise 2 drifter experiment. It consisted of a surface float and 21 sensors arrayed down to 29 m depth. 5 of those sensors were Seabird SBE37s, which include conductivity sensors. At ~30 m depth, an upward-looking Nortek ADCP was placed, with 11 bins between 30 m and the surface. See Figure 3.63. The drifter was deployed on 30-Oct-2017 22:52Z from the Revelle, near (8.6°N, 125°W) and recovered on 31-Oct-2017 21:56Z near (8.4°N, 124.8°W). See Figure 3.58 for path.

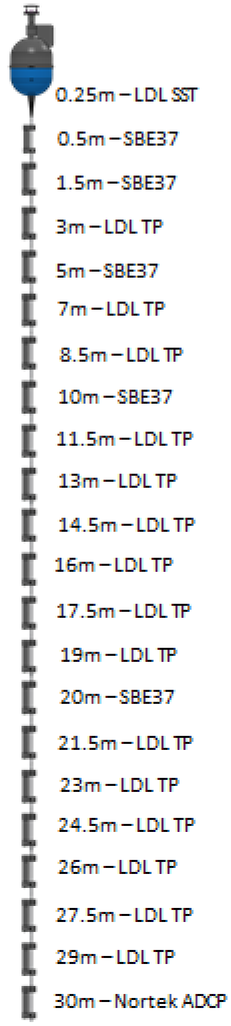


Figure 3.63. The configuration of the SADOS drifter. Each LDL TP measured temperature and pressure. Each SBE73 measured temperature, conductivity and pressure. The ADCP at 30 m was upward-looking. Figure courtesy of V. Hormann.

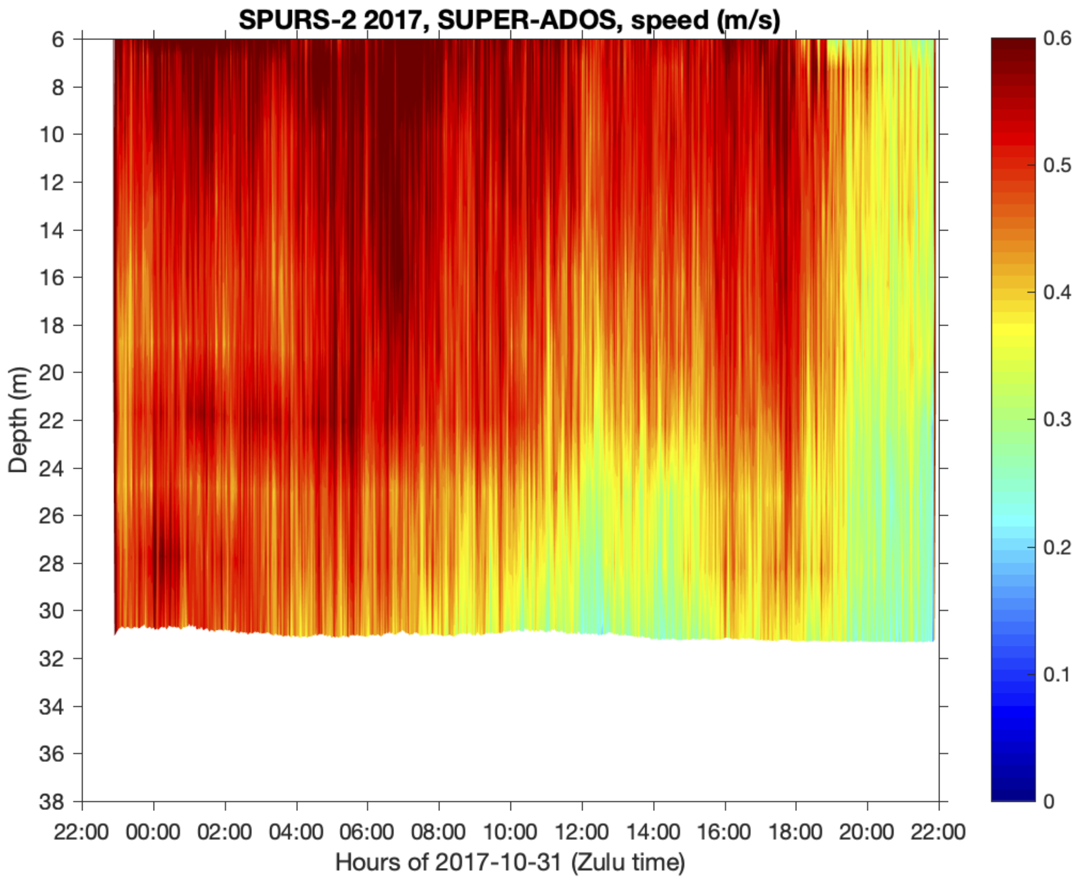


Figure 3.64. Velocity as a function of depth as measured from the S-ADOS drifter. Figure courtesy of V. Hormann.

3.4.4 CARTHE/SURPACT drifters

dx.doi.org/10.5067/SPUR2-DRIFT

Each CARTHE drifter was tied to a SURPACT wave rider. CARTHE drifter 5200300 was tethered to SURPACT wave rider 14495. It collected data from Nov-09-2017T13:15 to Nov-09-2017T17:40. CARTHE drifter 4733330 was tethered to SURPACT wave rider 14496. It collected data from Nov-09-2017T13:10 to Nov-09-2017T17:05. The CARTHE drifters collected sea water temperature at 36cm and 18cm and salinity at 36cm. Notice that the seawater temperatures at 18cm are biased. They come from a hull-sensor that is sensitive to inside-hull temperature. The SURPACT wave riders collected sea water temperature at 5 cm, sea water salinity at 5 cm, rainfall noise, and power spectra.

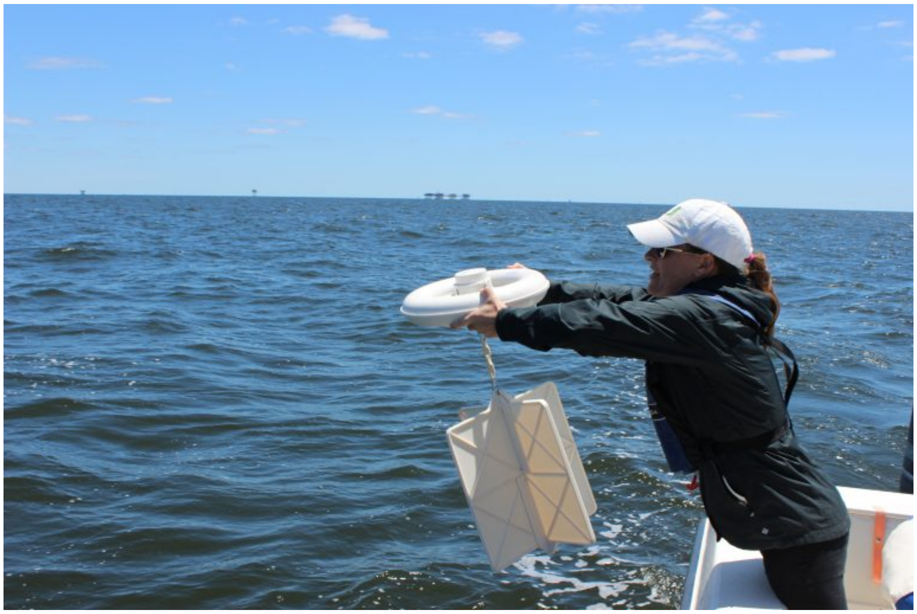


Figure 3.65. A CARTHE drifter being deployed (CARTHE 2016).

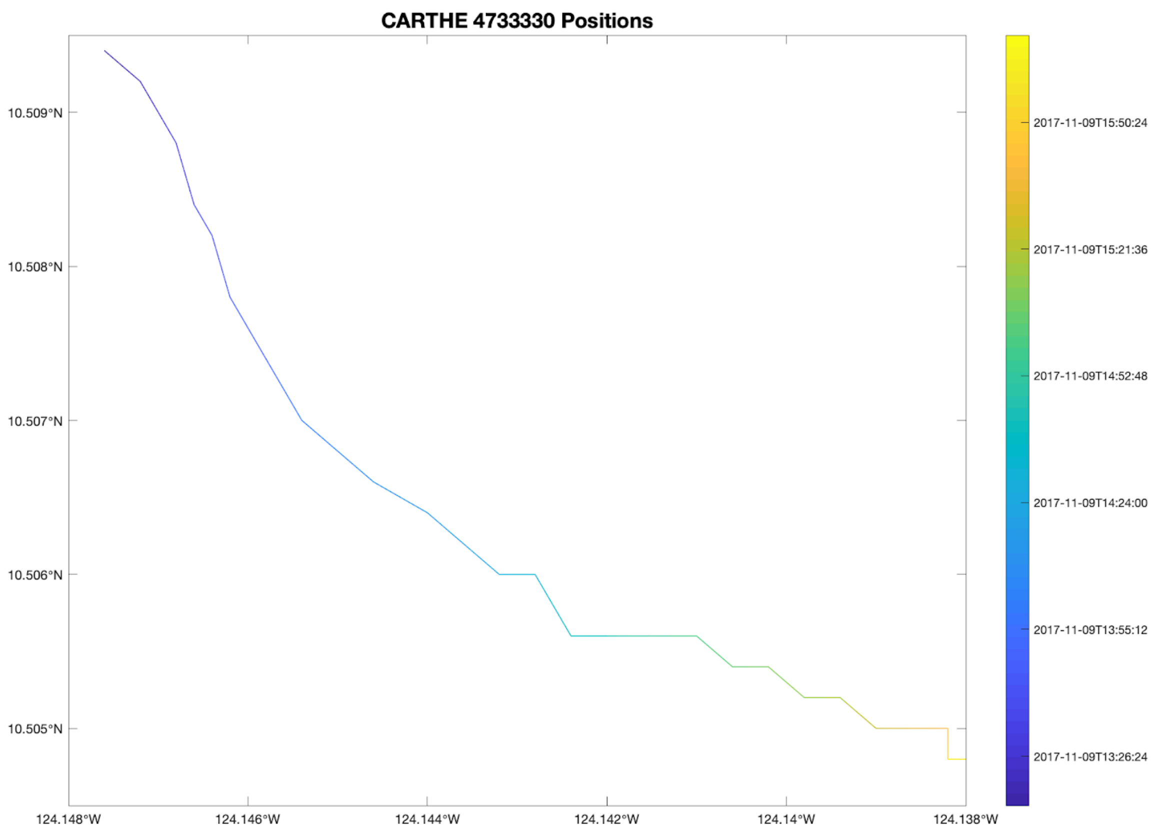


Figure 3.66. Trajectory of CARTHE 4733330 drifter.

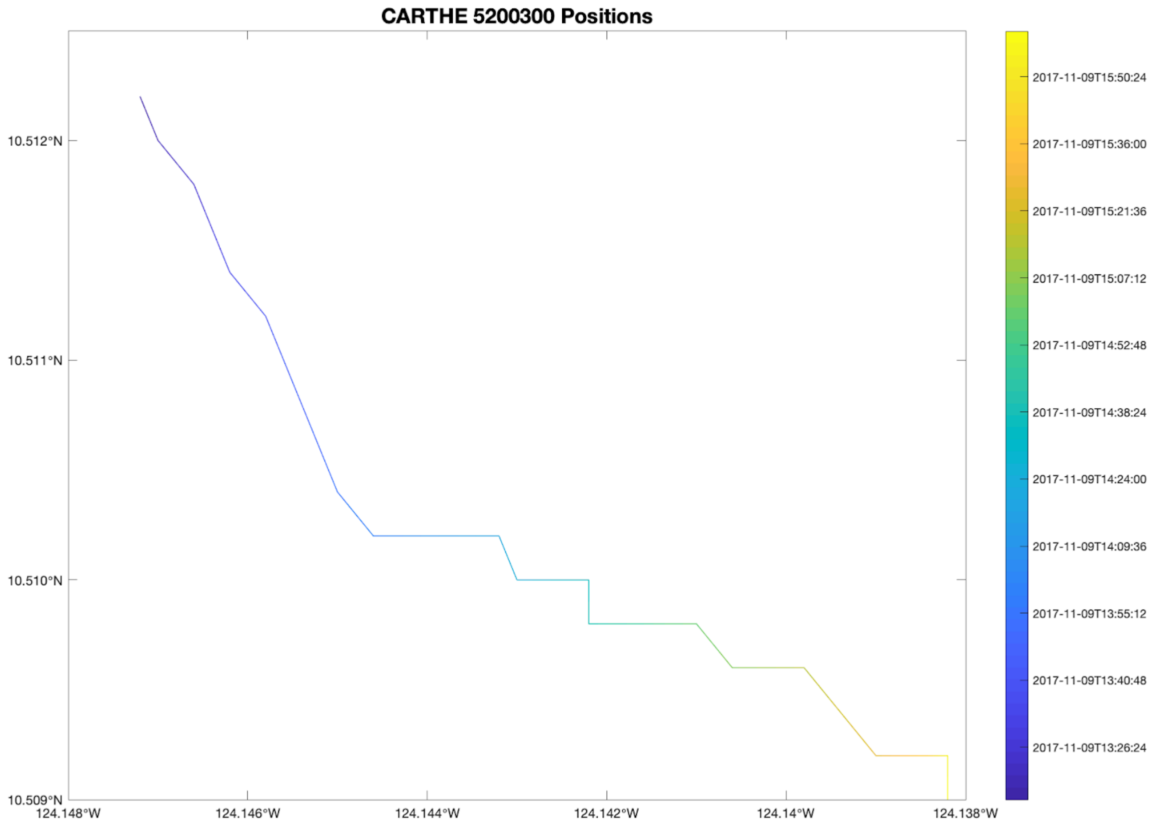


Figure 3.67. Trajectory of CARTHE 5200300 drifter.

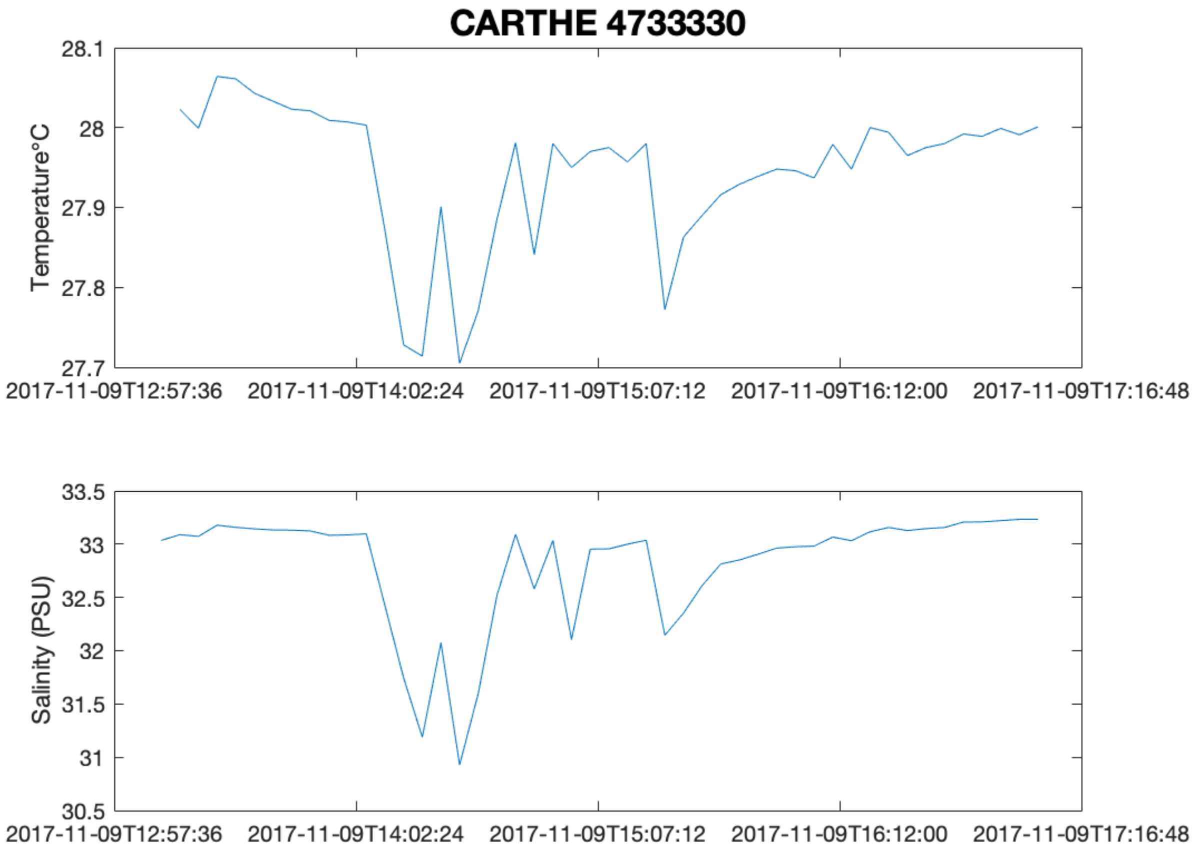


Figure 3.68. Seawater temperature and salinity at 36cm of CARTHE 4733330.

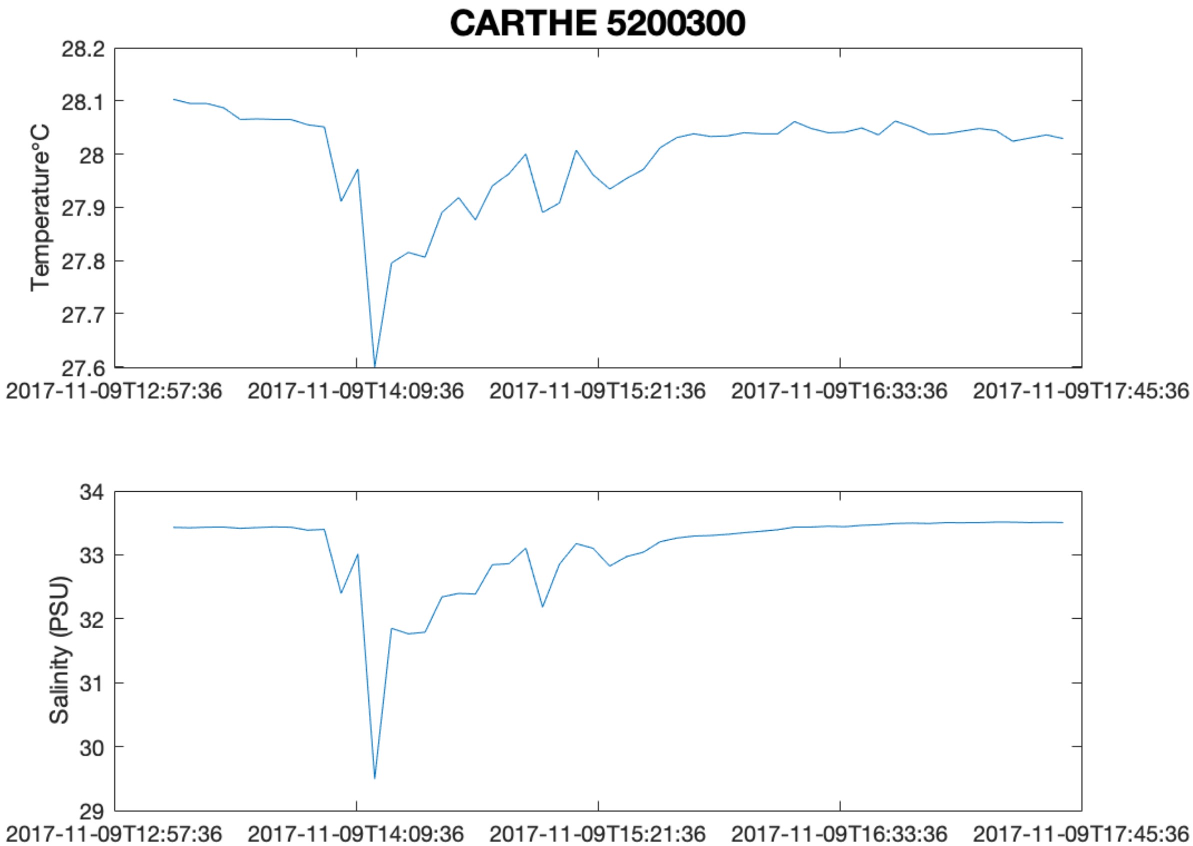


Figure 3.69. Seawater temperature and salinity at 36cm of CARTHE 5200300.

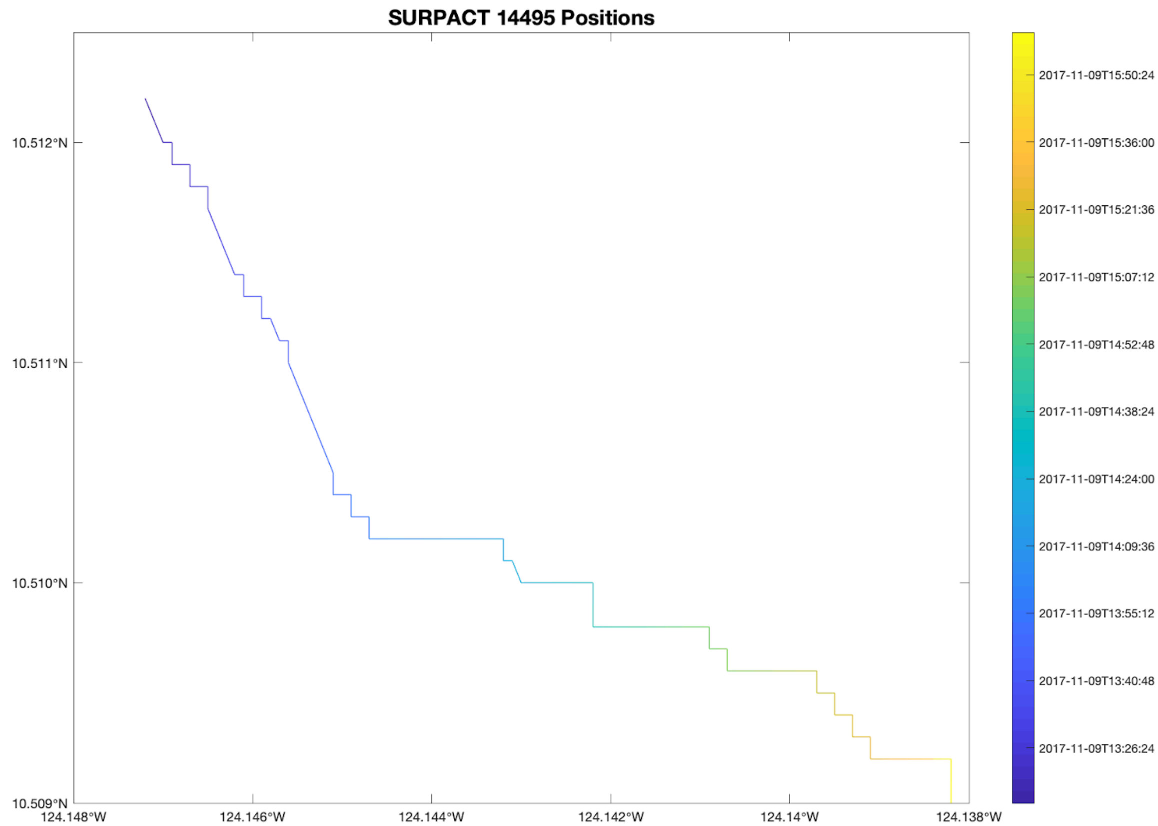


Figure 3.70. Trajectory of SURPACT 14495 wave rider.

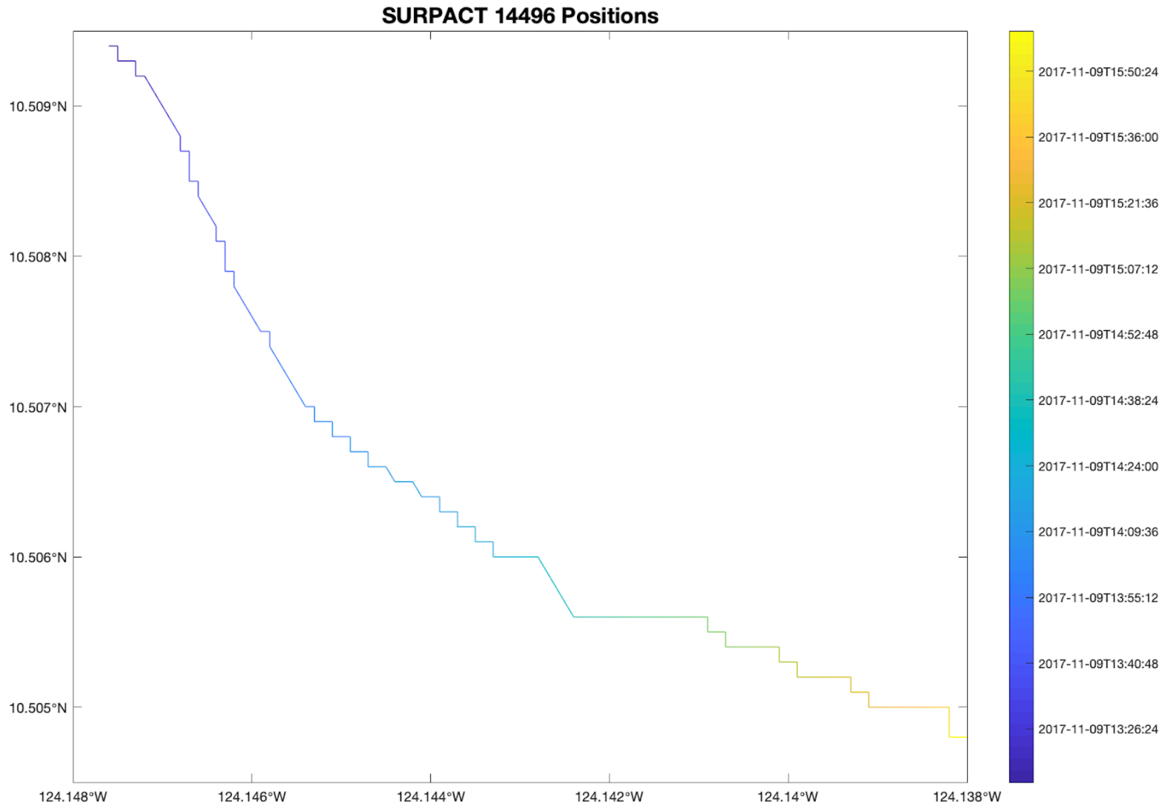


Figure 3.71. Trajectory of SURPACT 14496 wave rider.

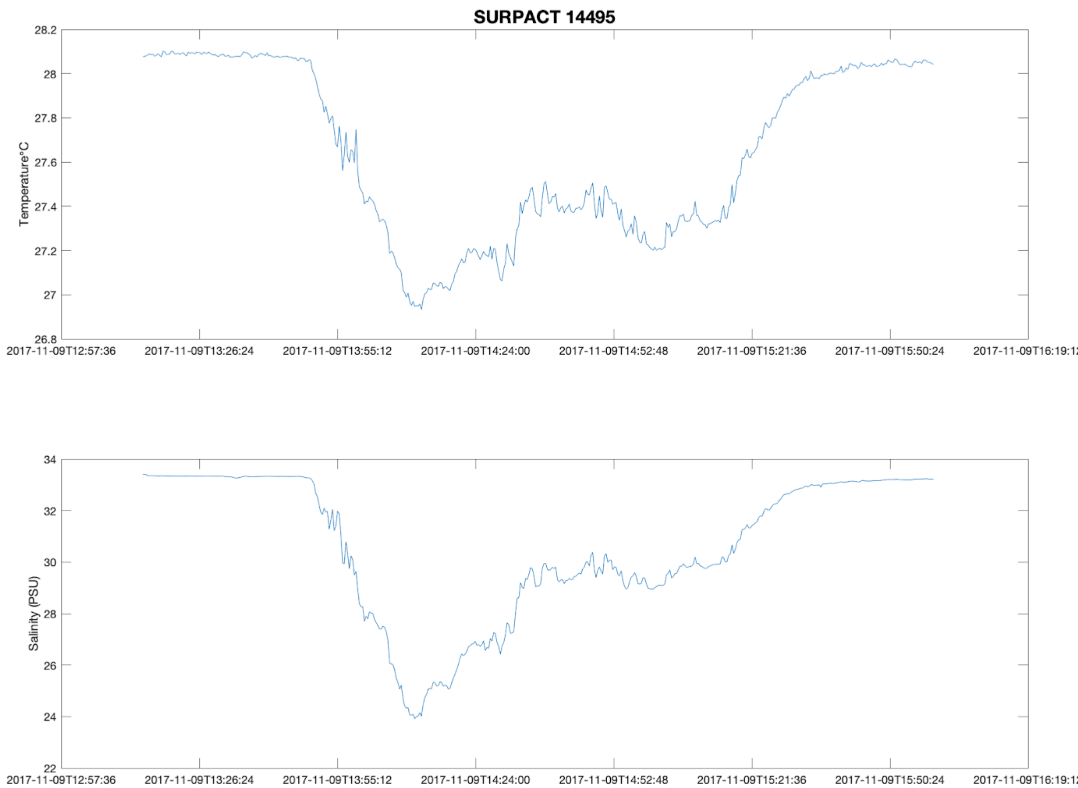


Figure 3.72. Seawater temperature and salinity at 5cm of SURPACT 14495.

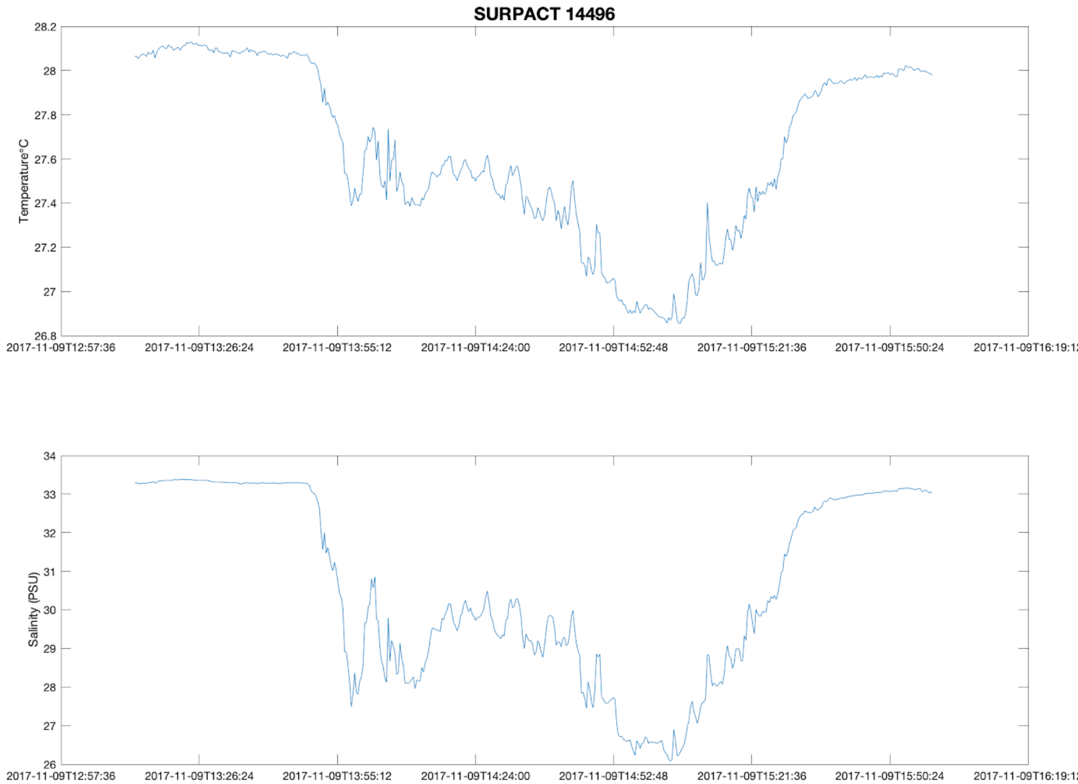


Figure 3.73. Seawater temperature and salinity at 5cm of SURPACT 14496.

3.4.5 AOML drifters

dx.doi.org/10.5067/SPUR2-DRIFT

There were 6 dual-sensor SVP drifters deployed on Revelle cruise 1 (Volkov et al., 2019). These drifters have SBE37 CTD sensors at 0.4 m and 5 m depth.

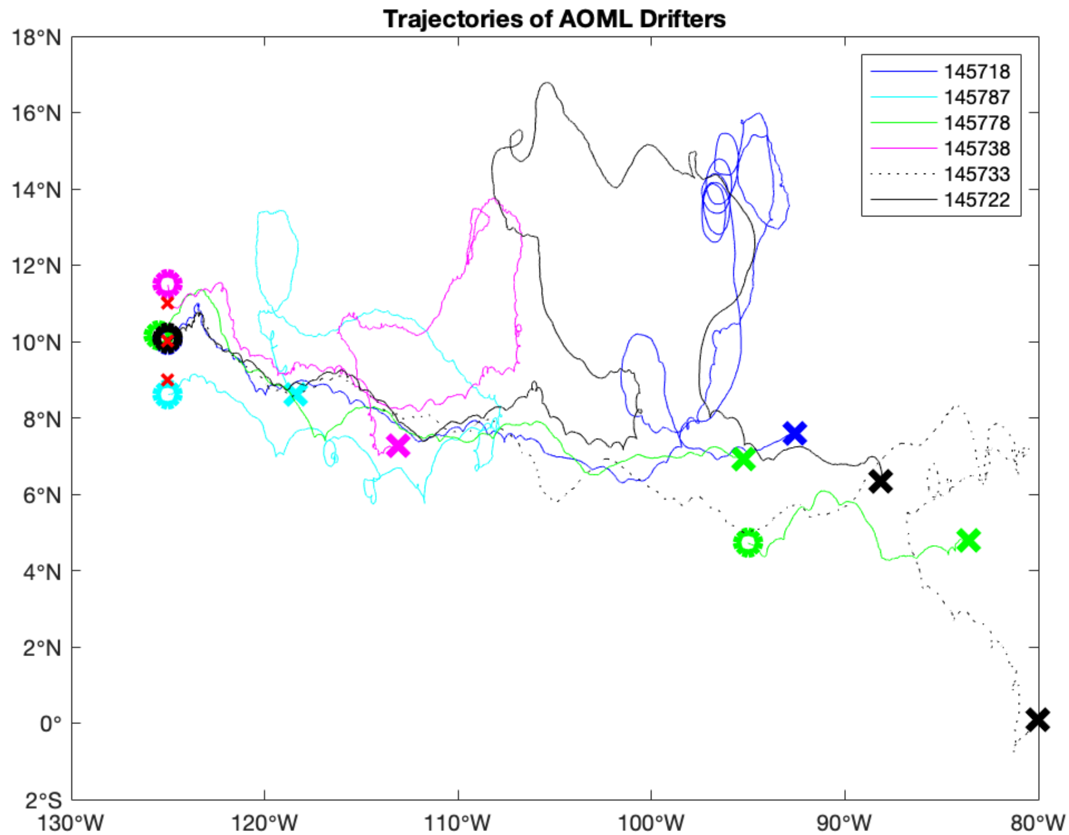


Figure 3.74. Trajectories of the AOML drifters (145718, 145787, 145778, 145738, 145733, and 145722) with the moorings (red x's) for reference. The (o's) indicate the deployment and the (X's) indicate the last recorded position for each drifter, with one exception. For drifter 145778, there is a gap in the record indicated by the "x" and "o" at 95°W.

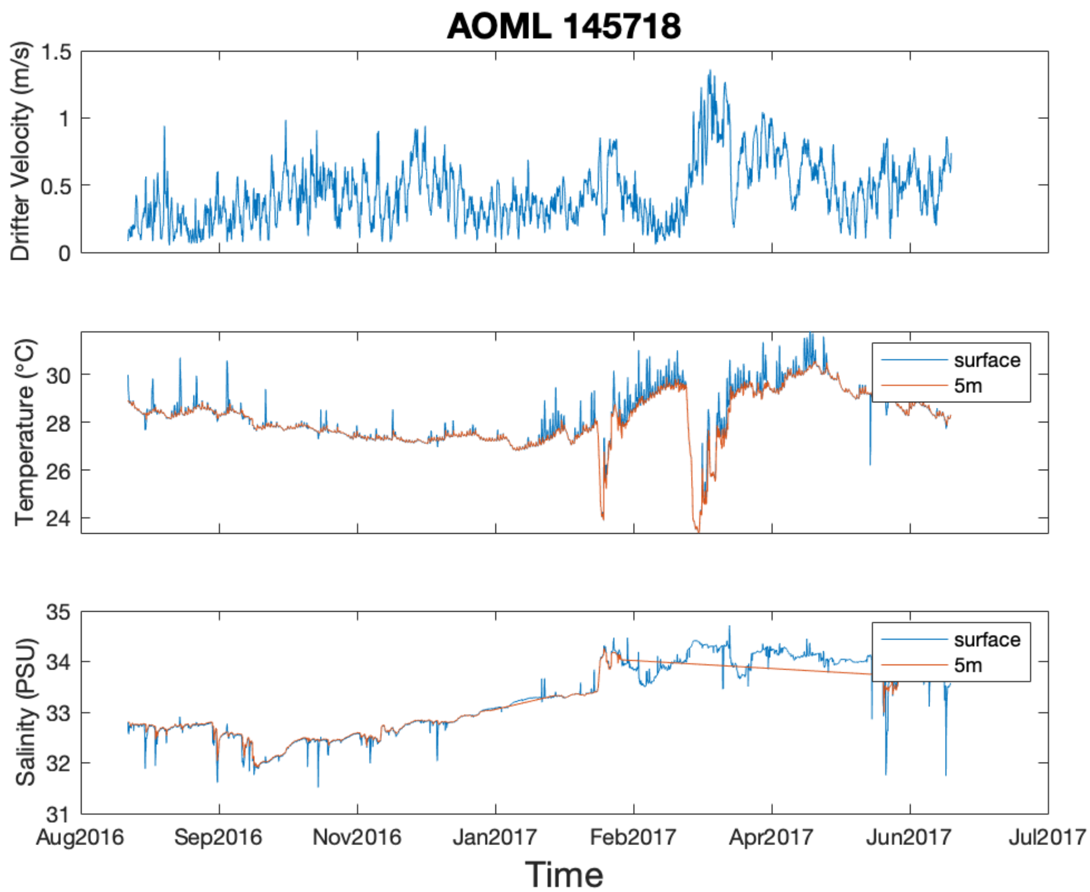


Figure 3.75. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145718.

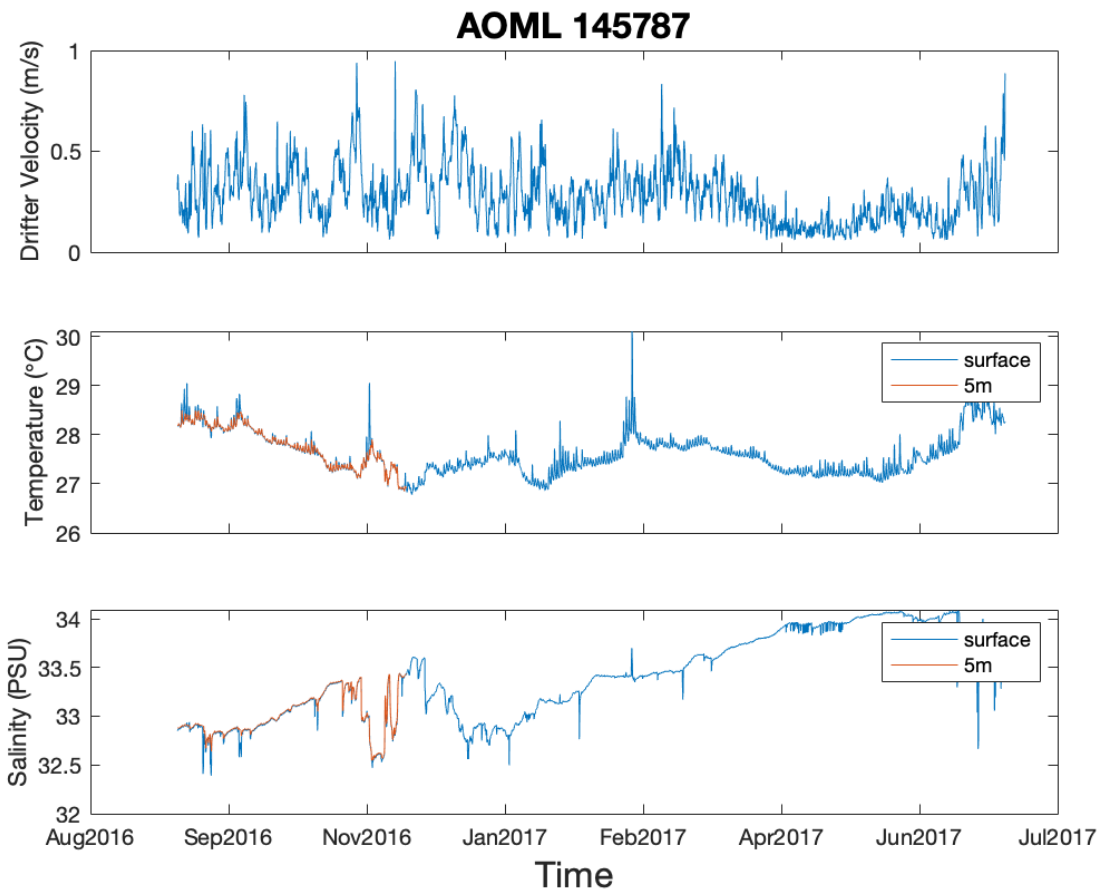


Figure 3.76. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145787.

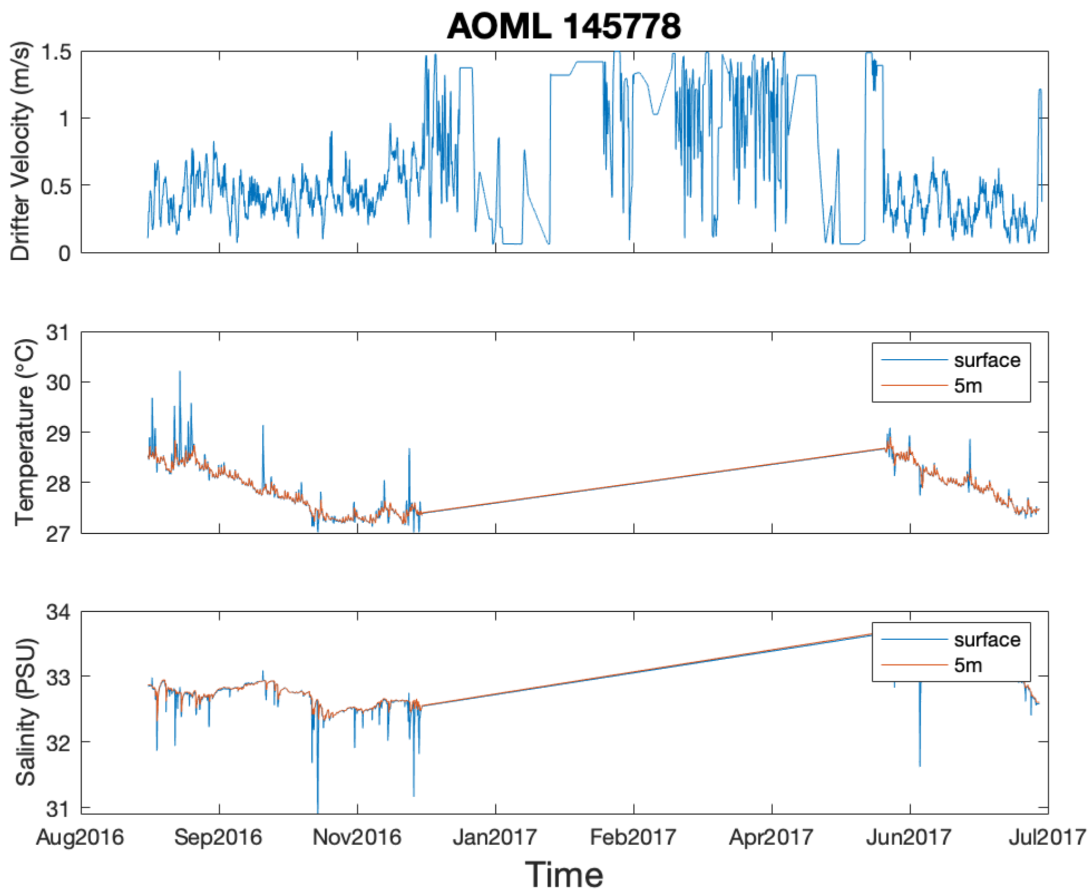


Figure 3.77. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145778.

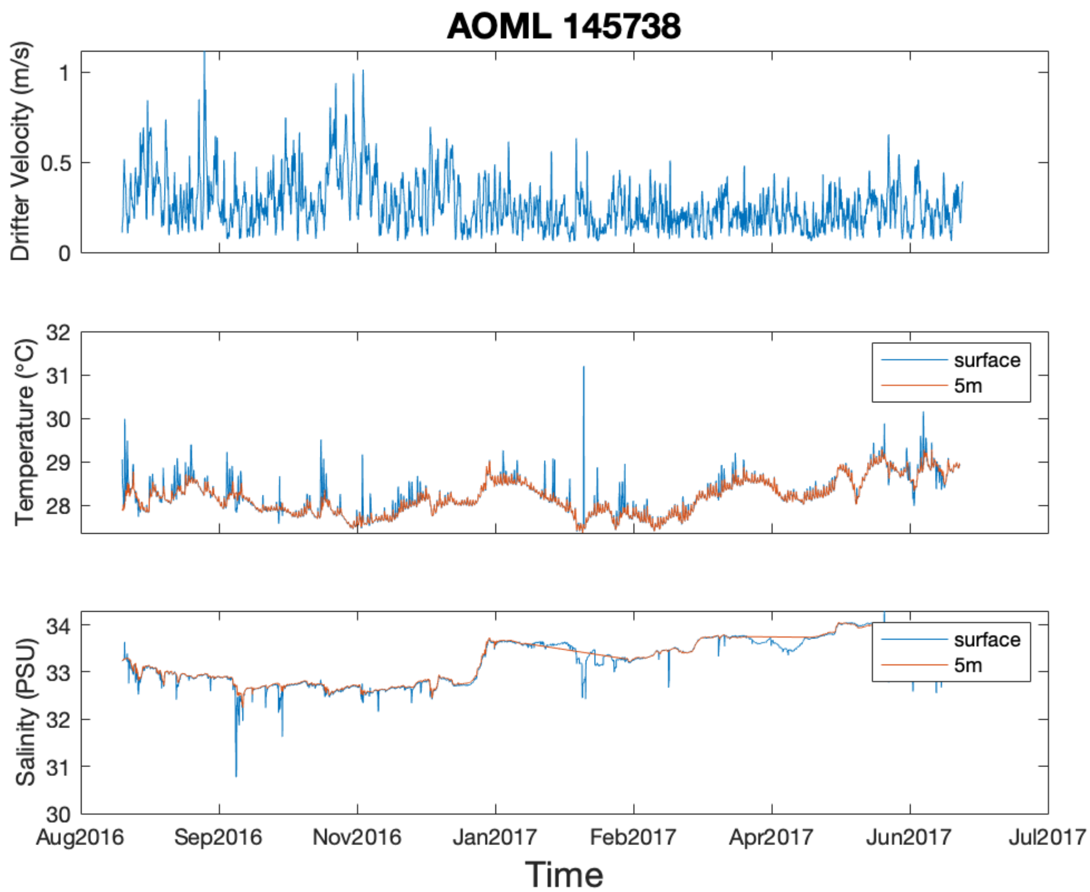


Figure 3.78. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145738.

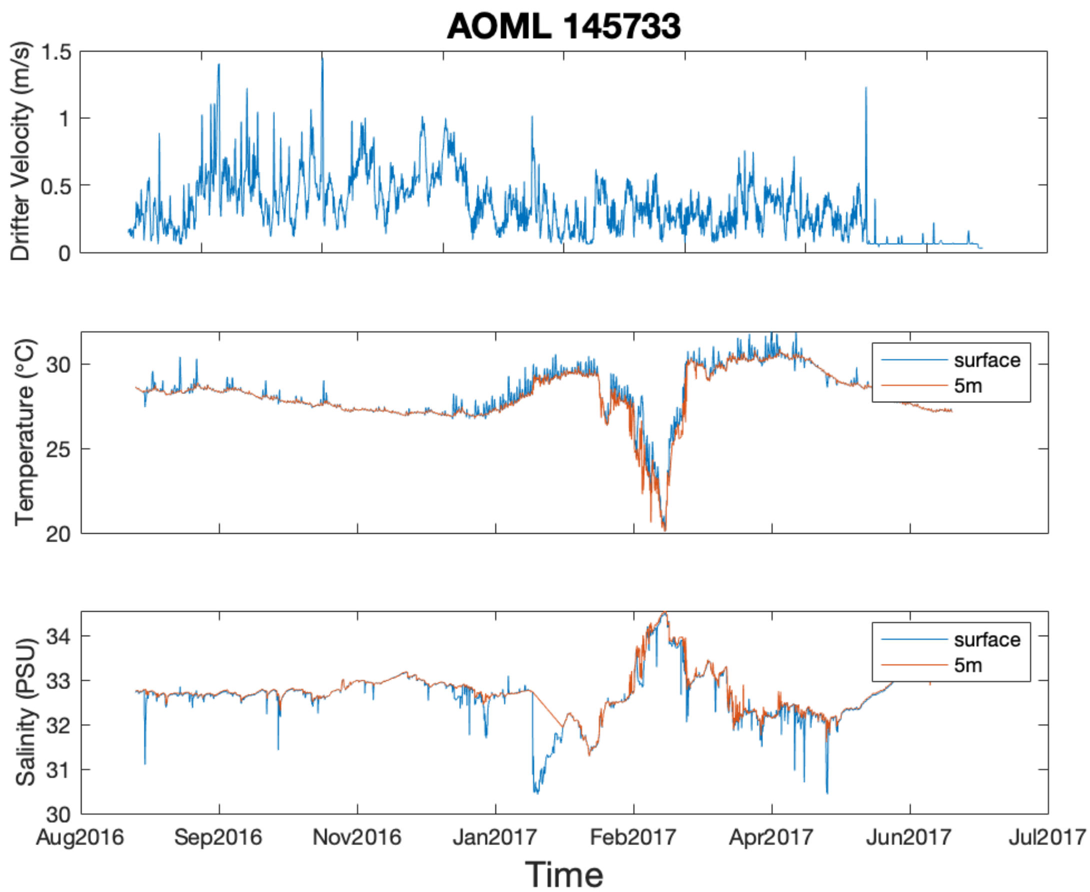


Figure 3.79. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145733.

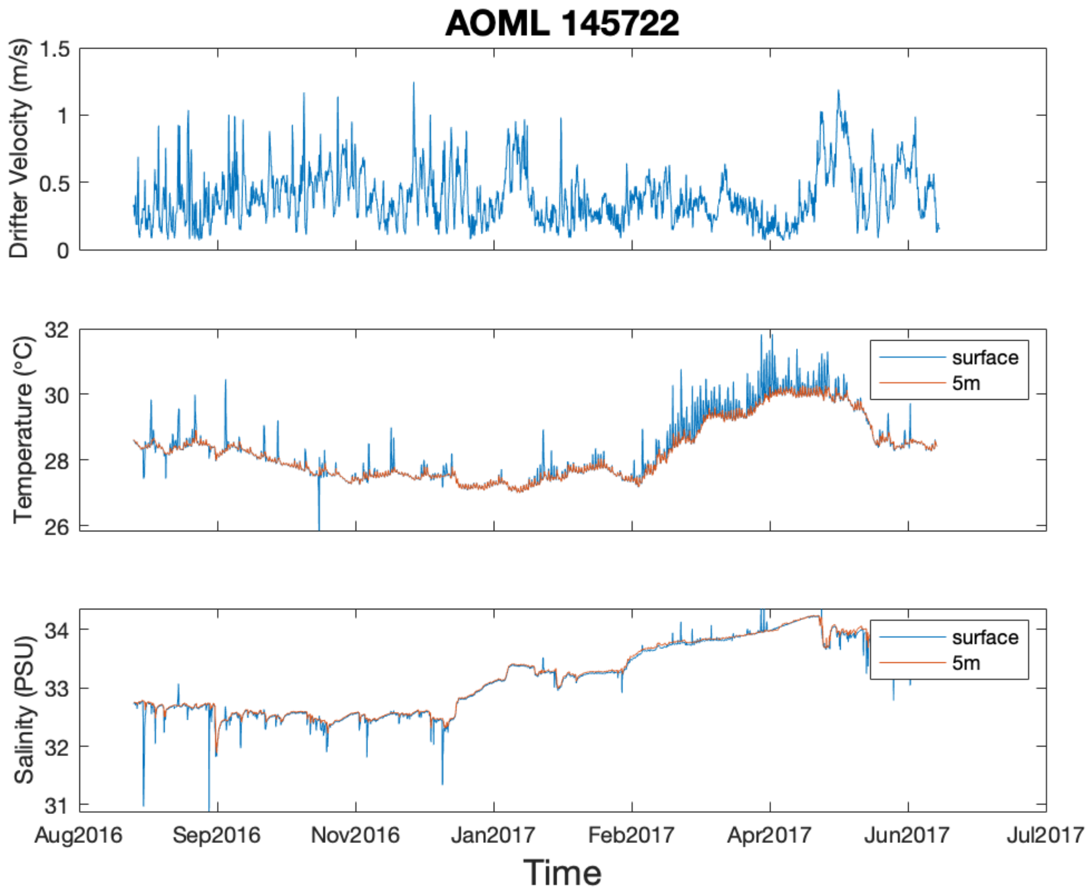


Figure 3.80. Drifter velocity, seawater temperature at the surface and at 5m, and seawater salinity at the surface and at 5m from AOML drifter 145722.

3.4.6 Mixed-layer float

dx.doi.org/10.5067/SPUR2-NBFLT

A mixed-layer Lagrangian float collected data from Aug-26-2016 to Dec-29-2016. There were two Sea-Bird Scientific SBE 41 CTD units at the top and bottom of the float that measured time, temperature, salinity, and pressure. A Druck PDCR 910-200 instrument was mounted to collect a “fast” very high resolution time and “fast” seawater pressure at the float center. A Garmin GPS 15H/L was also mounted to collect positions, latitudes and longitudes. (Shcherbina et al., 2019)

Figure 3.81. Mixed-layer float being deployed from R/V Roger Revelle. Photo courtesy of A. Jessup.

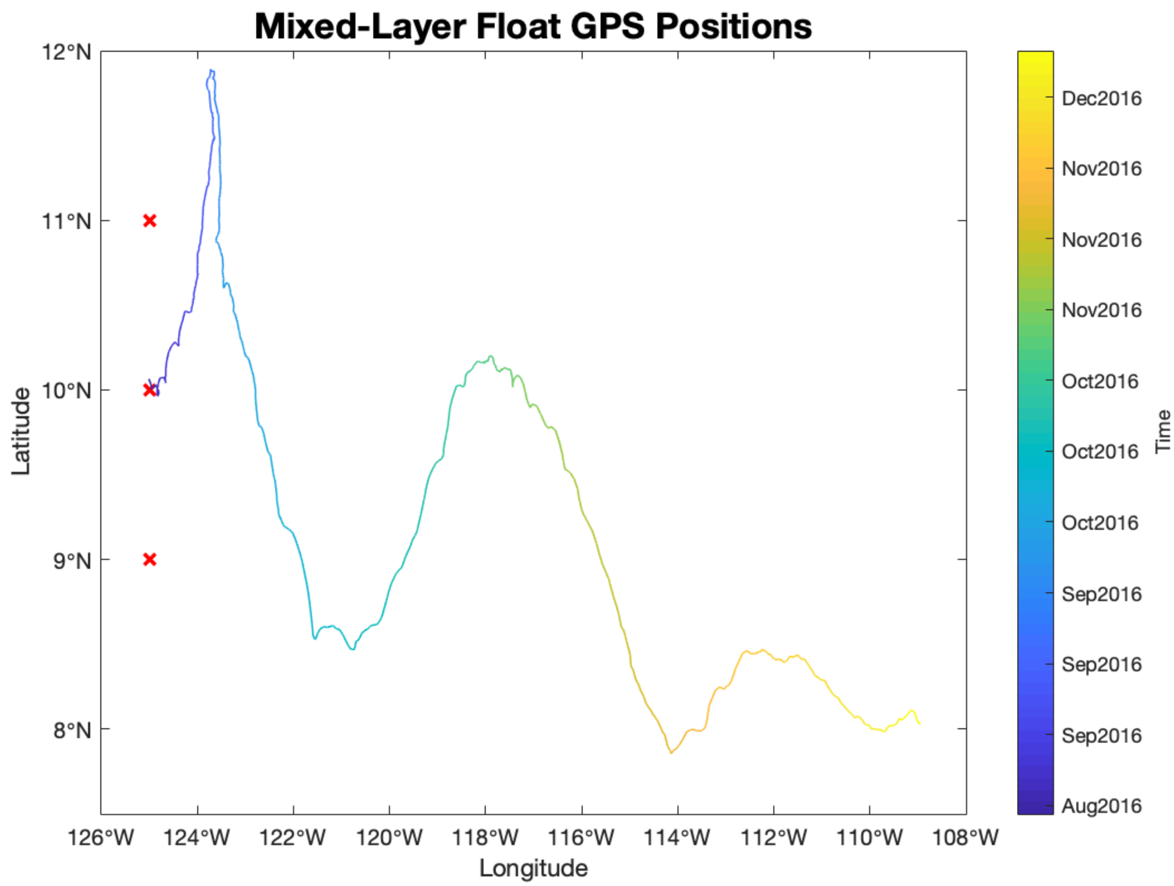


Figure 3.82. Trajectory of the Garmin GPS 15H/L positions of the mixed-layer float.

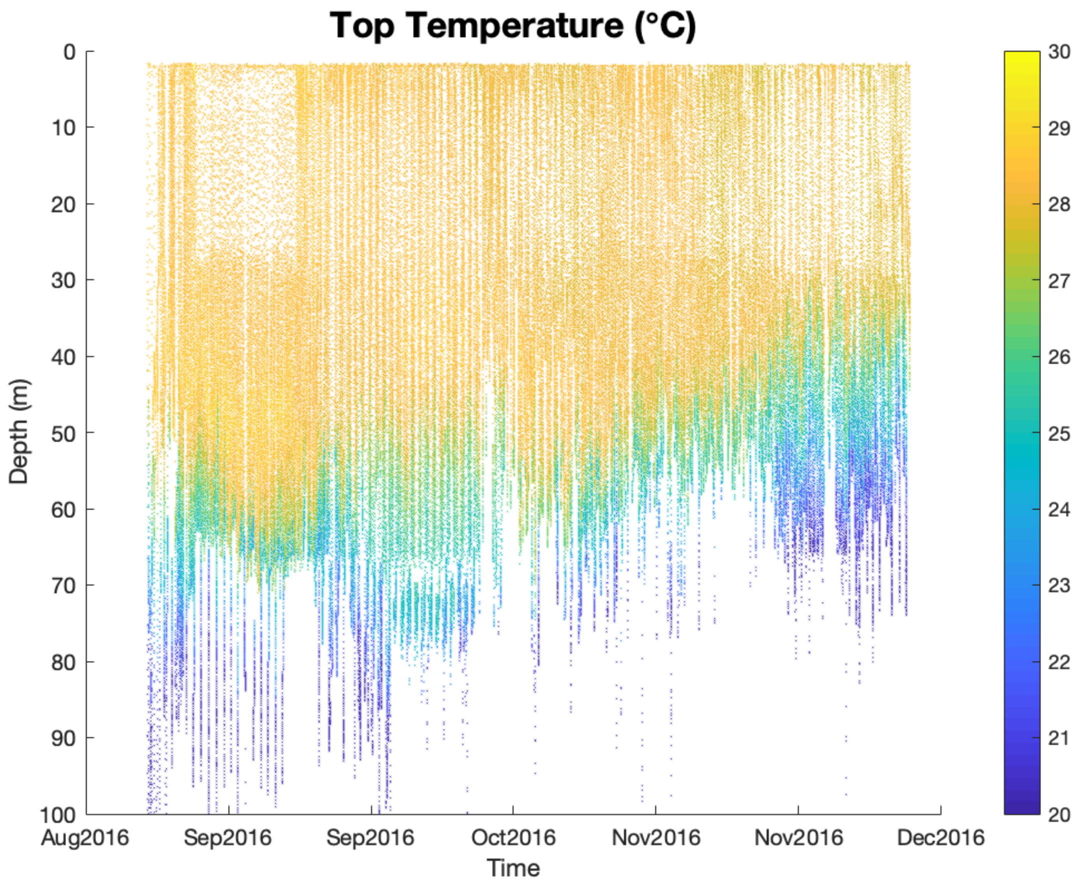


Figure 3.83. Seawater temperature from the top sensor of the Sea-Bird Scientific SBE 41 CTD.

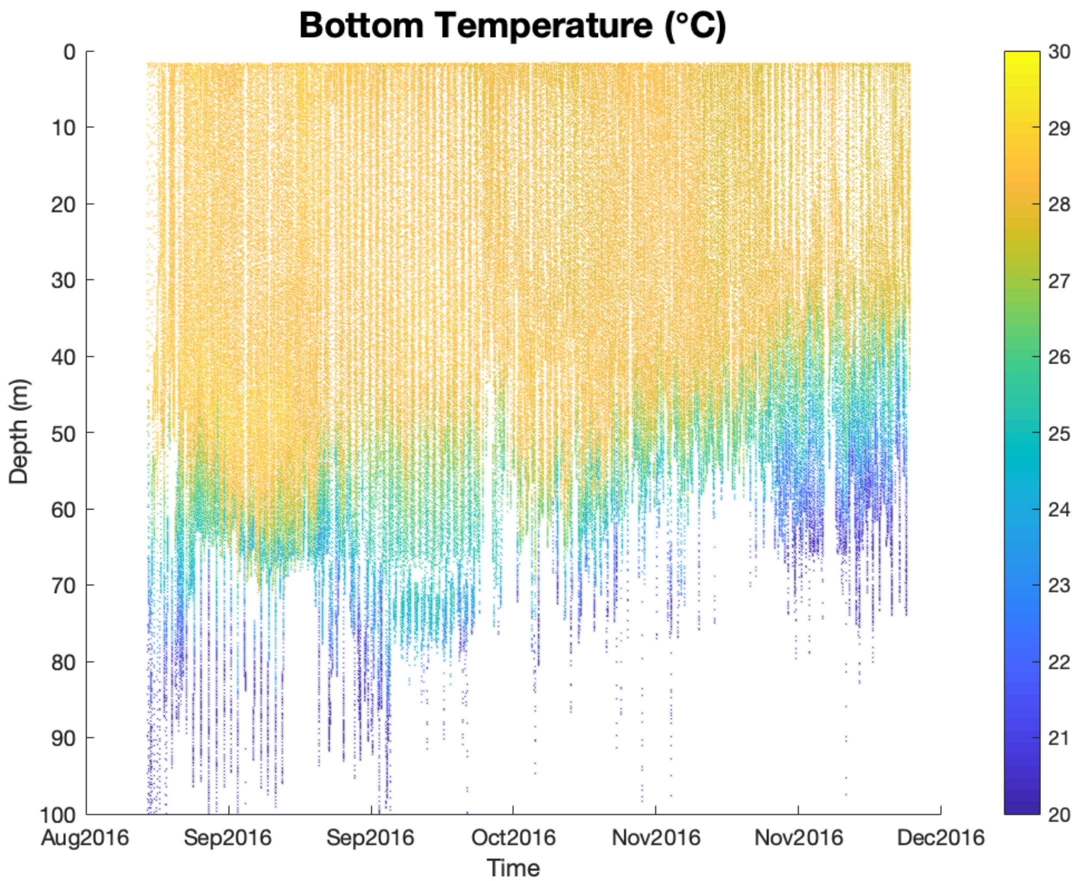


Figure 3.84. Seawater temperature from the bottom sensor of the Sea-Bird Scientific SBE 41 CTD.

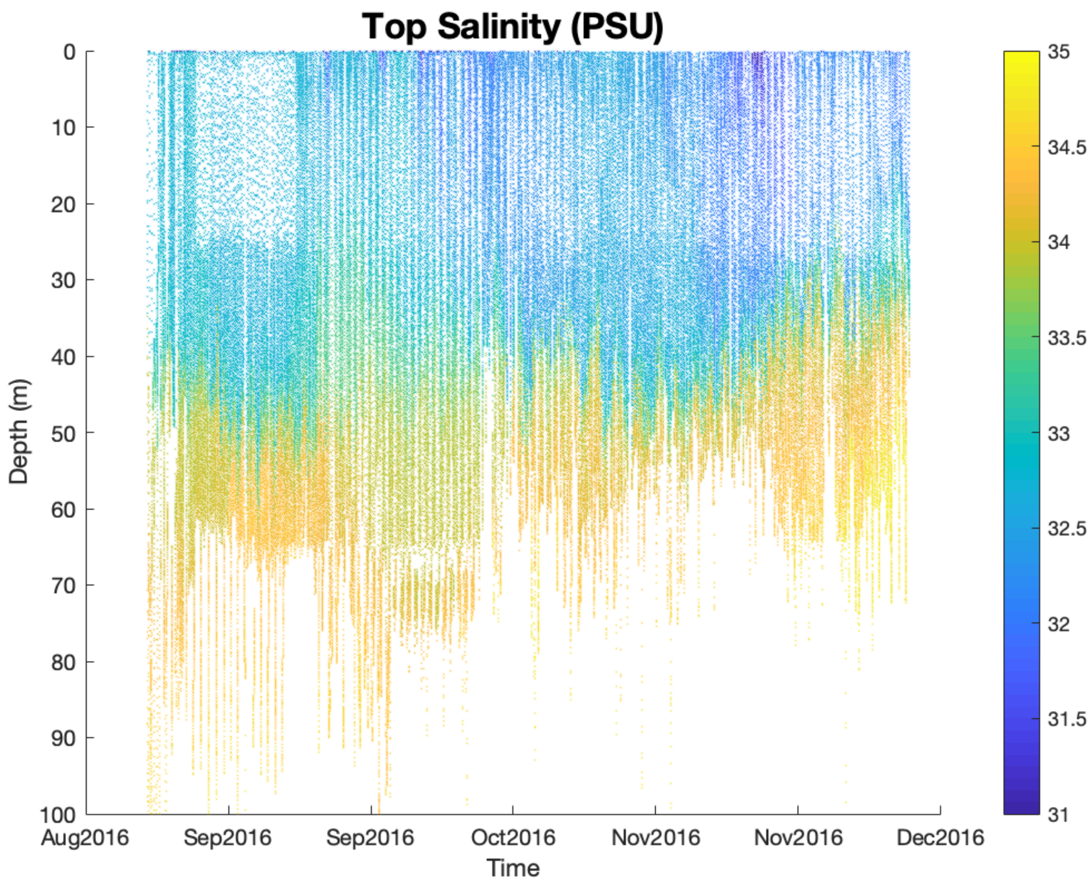


Figure 3.85. Seawater salinity from the top sensor of the Sea-Bird Scientific SBE 41 CTD.

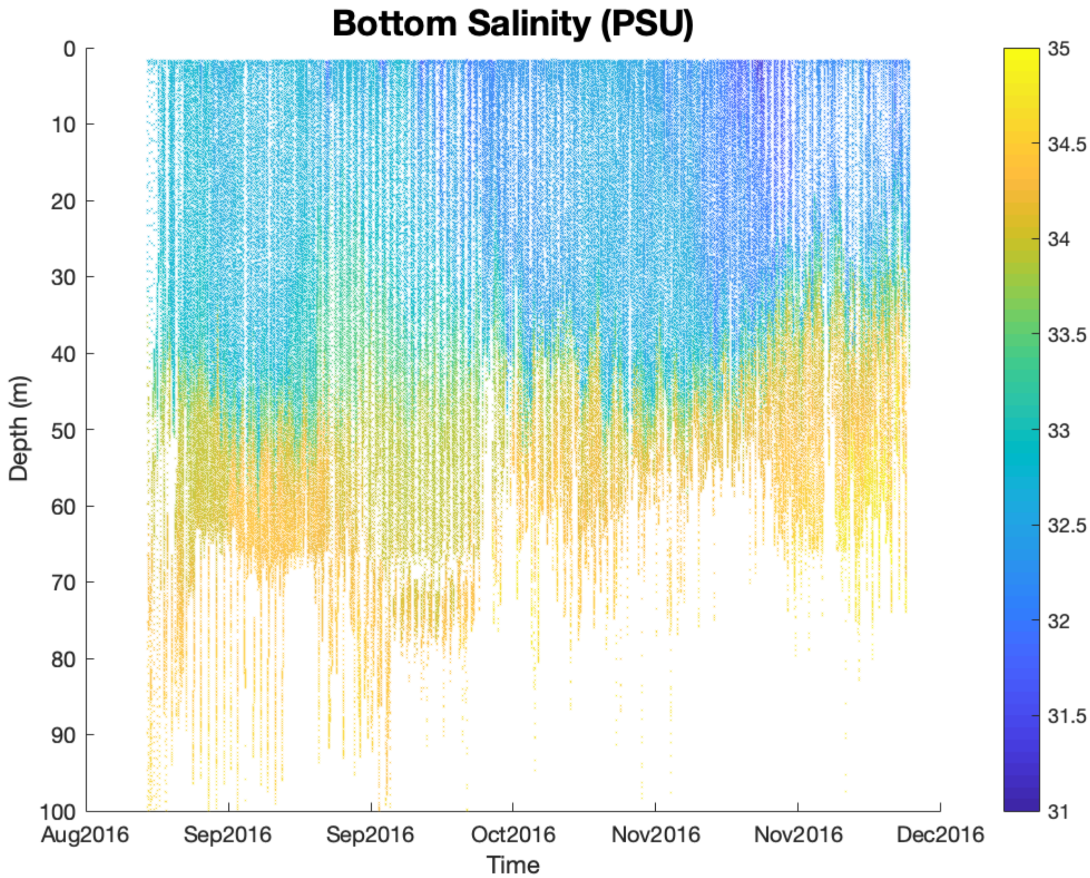


Figure 3.86. Seawater salinity from the bottom sensor of the Sea-Bird Scientific SBE 41 CTD.

3.4.7 Argo floats

dx.doi.org/10.5067/SPUR2-ARGO0

There were 25 Argo floats deployed from the Revelle during cruise 1 and 11 during cruise 2. Table 3 gives deployment dates and locations and WMO ID numbers. Tropical Pacific Observing System (TPOS) floats were deployed as part of a pilot program and featured, along with standard CTD and communication capabilities, sensors for dissolved oxygen, chlorophyll fluorescence, optical backscatter and a hydrophone for measuring ambient noise (Drushka, 2018).

Table 3. Information about Argo floats deployed from the Revelle as part of SPURS-2.

University of Washington ID number	Revelle Deployment cruise #	Deployment Date (year-month-day)	Deployment Location (°N, °E)	WMO ID number*	Float type**

8435	1	2016-8-30	9.48, -126.01	5904668	T
8444	1	2016-9-5	10.02, -123.98	5904762	T
9302	1	2016-9-4	9.00, -124.48	5904775	T
9711	1	2016-8-31	10.96, -125.58	5904776	T
12360	1	2016-9-3	10.54, -124.99	5904777	T
12406	1	2016-9-9	10.30, -124.94	5904786	A
12408	1	2016-9-10	9.52, -124.99	5904780	A
12433	1	2016-9-10	8.07, -125.02	5904782	A
12448	1	2016-8-27	10.07, -124.97	5904779	A
12450	1	2016-9-10	6.50, -124.99	5904783	A
12452	1	2016-9-11	5.18, -124.94	5904787	A
12453	1	2016-9-9	10.97, -125.01	5904785	A
12455	1	2016-9-10	8.77, -124.99	5904784	A
12457	1	2016-9-10	7.24, -125.00	5904778	A
12619	2	2017-10-27	9.01, -124.79	5905365	A
12636	2	2017-10-27	9.51, -124.78	5905363	A
12637	2	2017-11-3	9.06, -124.92	5905358	A
12650	2	2017-10-31	8.58, -124.89	5905362	A
12651	2	2017-10-26	8.48, -124.82	5905360	A
12653	2	2017-11-3	9.48, -124.95	5905357	A
12654	2	2017-11-3	8.49, -124.94	5905359	A
12656	2	2017-11-4	10.02, -124.98	5905361	A
12659	2	2017-10-2	10.02, -124.78	5905364	A
12717	2	2017-10-29	4.91, -124.94	5905139	T
12728	2	2017-10-26	7.34, -124.67	5905140	T

*Current float trajectory maps and data can be accessed by going to the Argo data management website (link below) and entering the WMO ID number in the “Platform code” box.

http://www.argodatamgt.org/Access-to-data/Description-of-all-floats2

**Float types: “A” Standard Argo float. “T” TPOS float.

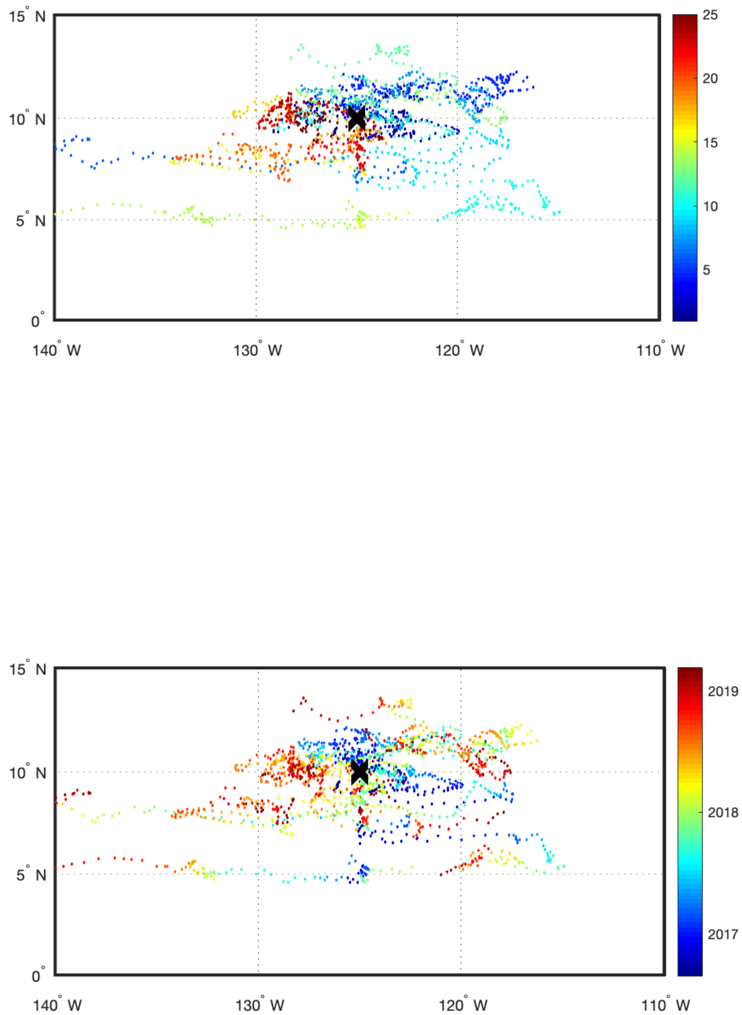


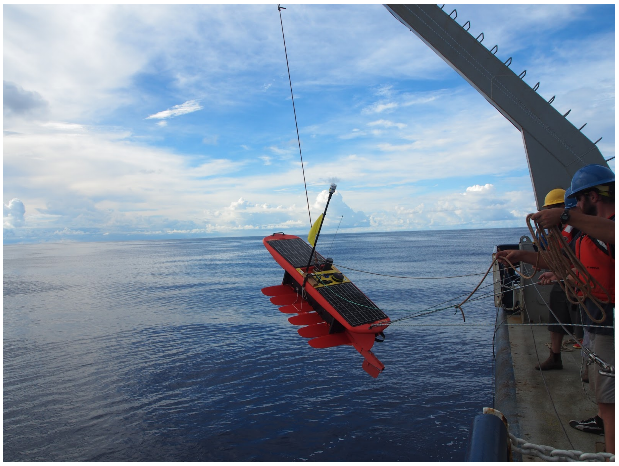
Figure 3.87. Locations of Argo float profiles by (top panel) number (each float has a different color) and (bottom panel) date, as of March 2019.

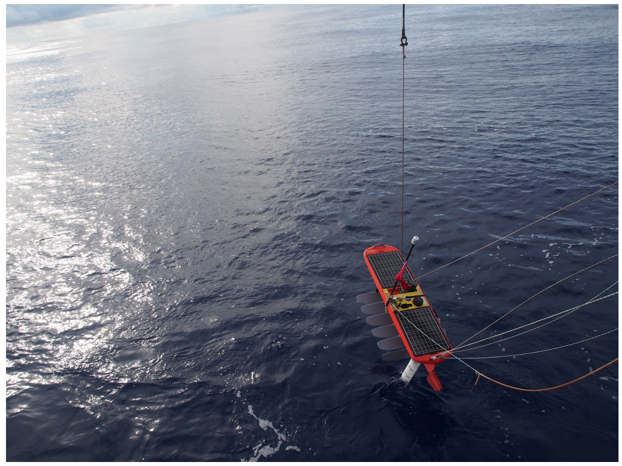
3.5 Autonomous platforms

3.5.1 Wavegliders

dx.doi.org/10.5067/SPUR2-GLID3

Three Waveglider (ASL 22, 32, and 42) instruments were deployed in the SPURS-2 region over the course of the two R/V Roger Revelle cruises from August 2016 to November 2017. Lower and upper measurements were archived from the Waveglider that include sea water salinity, sea water temperature, and sea water pressure. Meteorological data from an Airmar WX200 instrument on a 1-meter-tall mast were archived, including; wind direction, wind speed, air temperature, and air pressure.





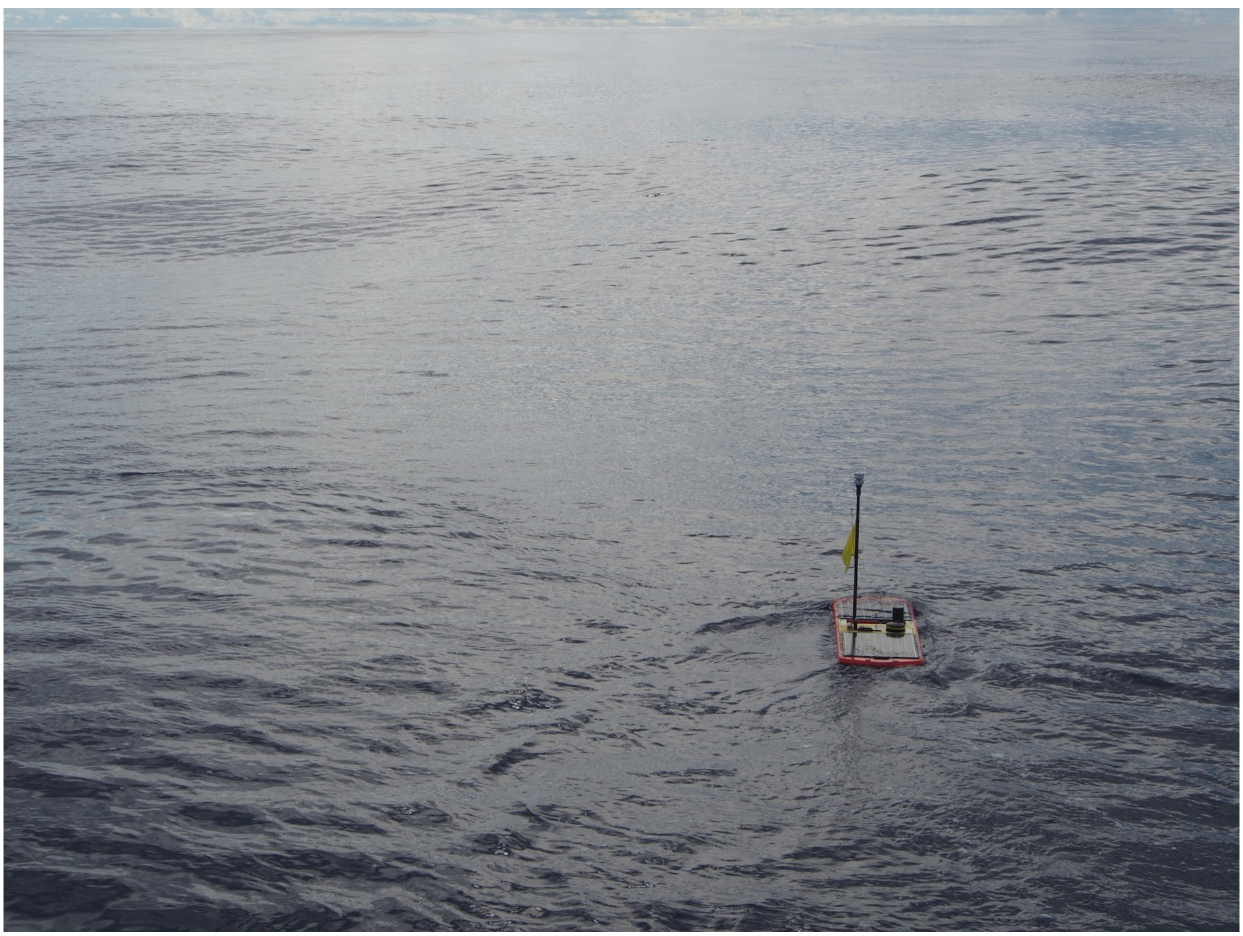


Figure 3.88. Waveglider being deployed from R/V Roger Revelle on cruise 1. Photo courtesy of Audrey Hasson.

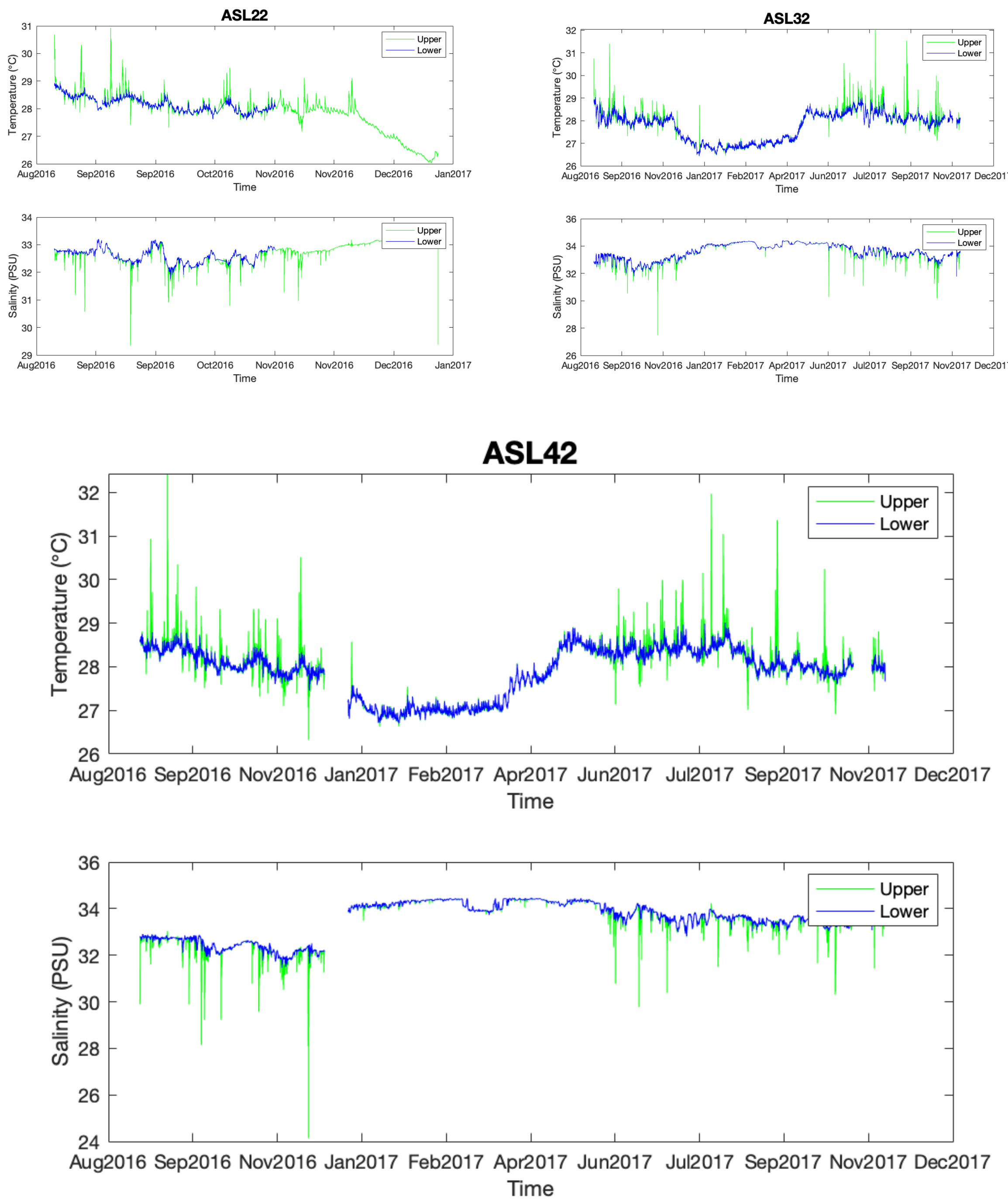


Figure 3.89. Temperature and salinity at upper and lower levels from Wavegliders (ASL 22, ASL 32, and ASL 42).

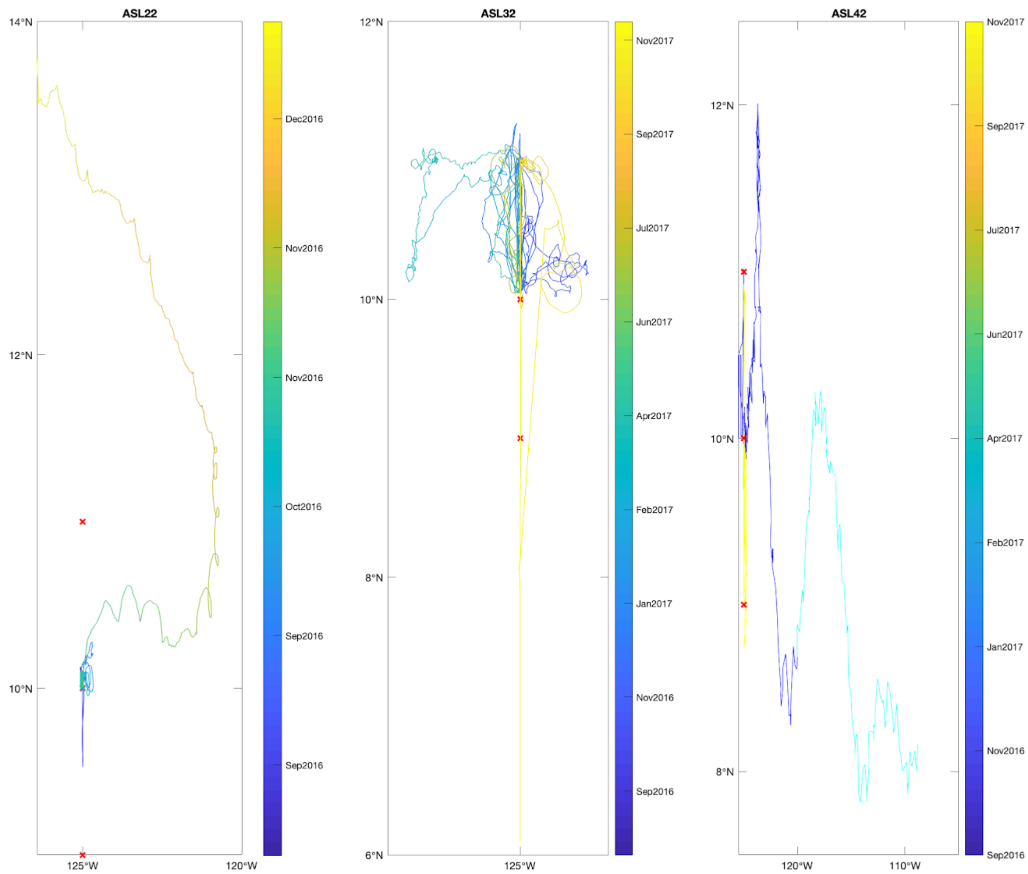


Figure 3.90. Trajectory of the Waveglider instruments (ASL 22, ASL 32, and ASL 42) with the central mooring (red x's) for reference.

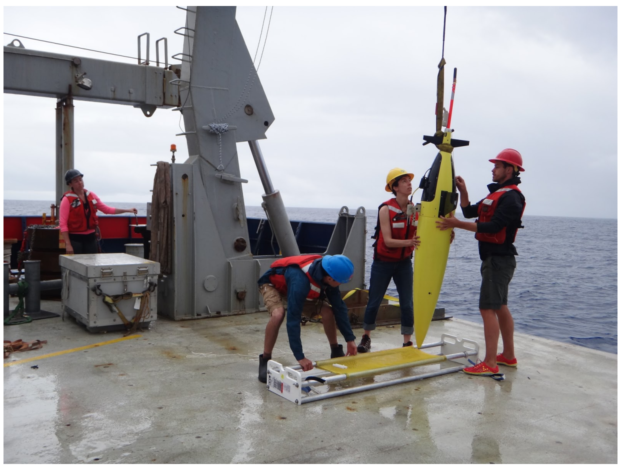
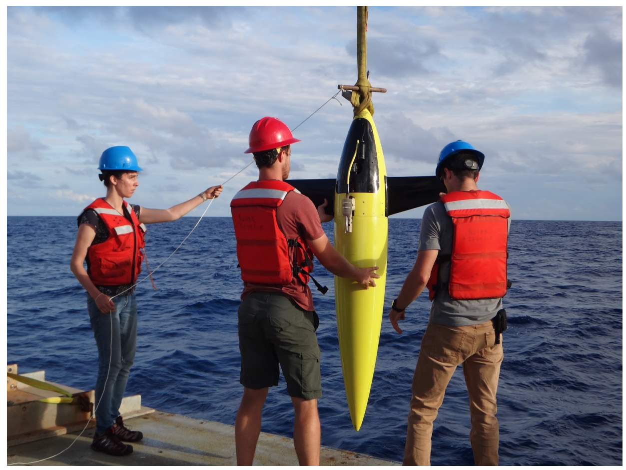
3.5.2 Seagliders

dx.doi.org/10.5067/SPUR2-GLID1

Three Seaglider instruments (190, 191, and 220) were deployed from the Revelle during the first cruise (Table 4). They were recovered by the LA in August 2017 during its fourth cruise. Two additional Seaglider instruments (144 and 219) were deployed from the LA on that same cruise. Data was archived from upcasts and downcasts to a depth of 1000 meters. Variables include Seaglider dive displacement, eastward and northward velocities, surface eastward and northward currents, temperature, sigma-t, and salinity.

Table 4. Seaglider start and end dates for data collection.

Seaglider #	Data collection start	Data collection end
190	26-Aug-2016	8-May-2017
191	26-Aug-2016	29-Apr-2017
220	24-Aug-2016	3-May-2017
144	29-Aug-2017	6-Nov-2017
219	30-Aug-2017	6-Nov-2017

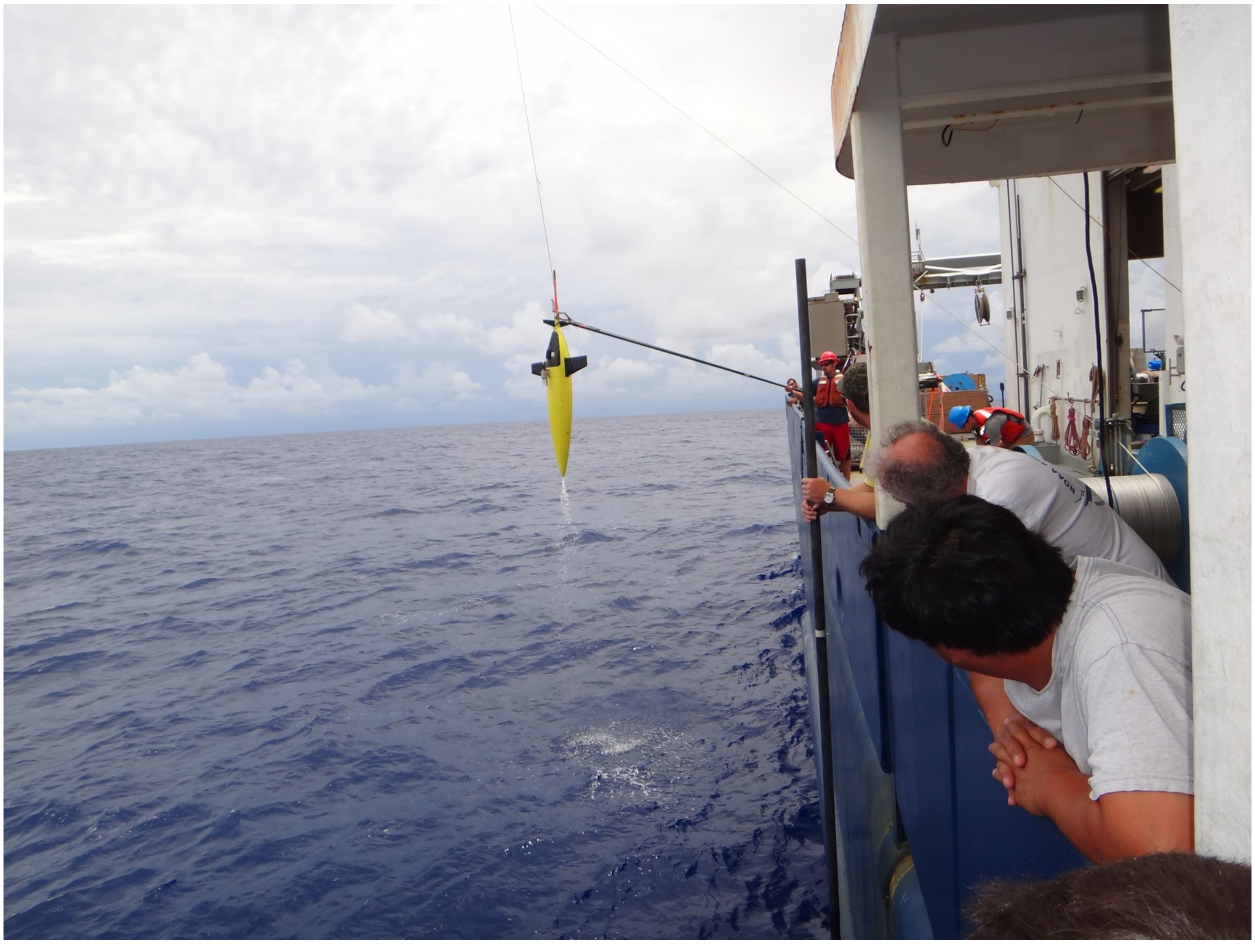
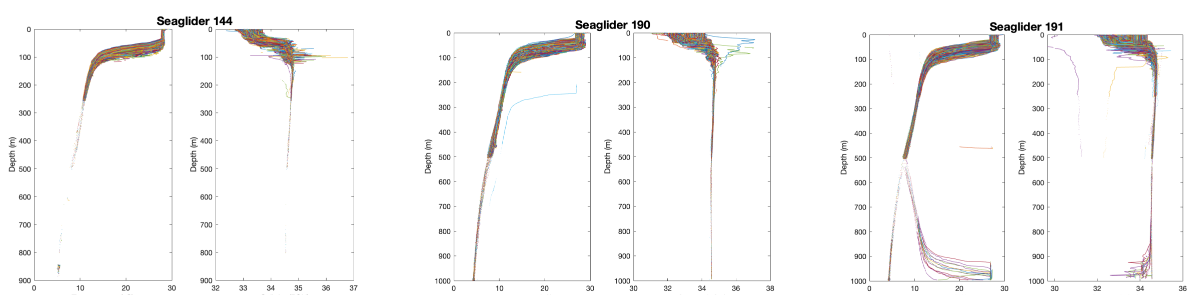


Figure 3.91. Seaglider being deployed from R/V Roger Revelle.



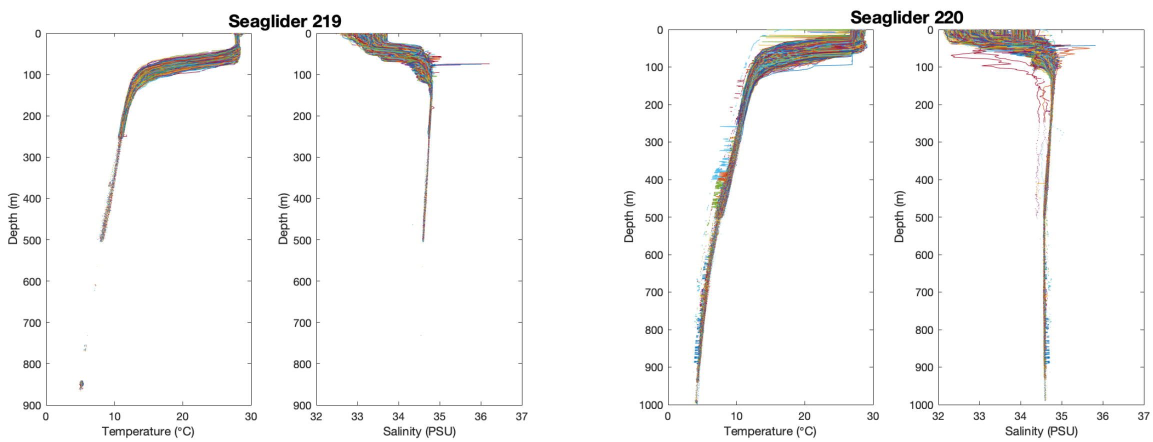


Figure 3.92. Temperature and salinity vs. depth from Seagliders 144, 190, 191, 219, and 220.

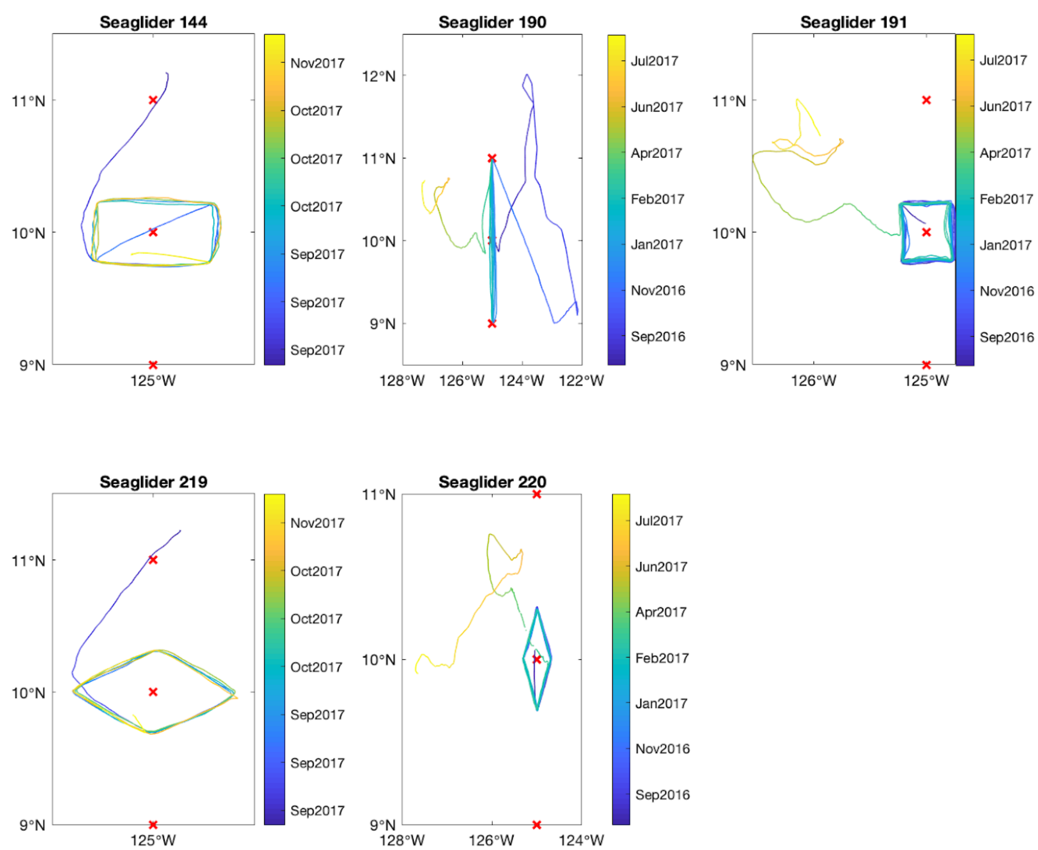


Figure 3.93. Trajectory of the Seaglider instruments (144, 190, 191, 219, and 220) with the moorings (red x's) for reference.

3.5.3 Saildrones

dx.doi.org/10.5067/SPUR2-SDRON

Two saildrones (S/N 1005 and 1006) were deployed and sampled the SPURS-2 region during the second Revelle cruise (Zhang et al., 2019; Fig. 3.95). The archived data cover the period between 16-Oct and 17-Nov-2017. They collected meteorological variables: air temperature (at 2.4 and 10 m), relative humidity (at 2.4 and 10 m), specific humidity (at 2.4 and 10 m), sea level pressure, wind speed (at 5 and 10 m) and direction, solar radiation, and longwave radiation; plus SST and SSS. Detailed comparisons between the saildrone and buoy surface fluxes are described by Zhang et al.

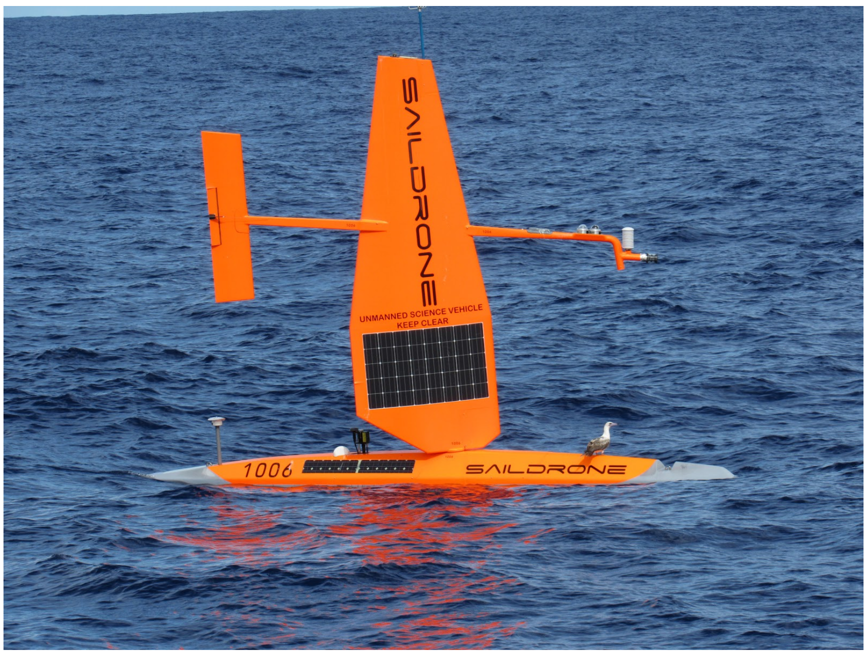


Figure 3.94. Saildrone taken from the Revelle on 8-November-2017. Image courtesy of Eric Lindstrom.

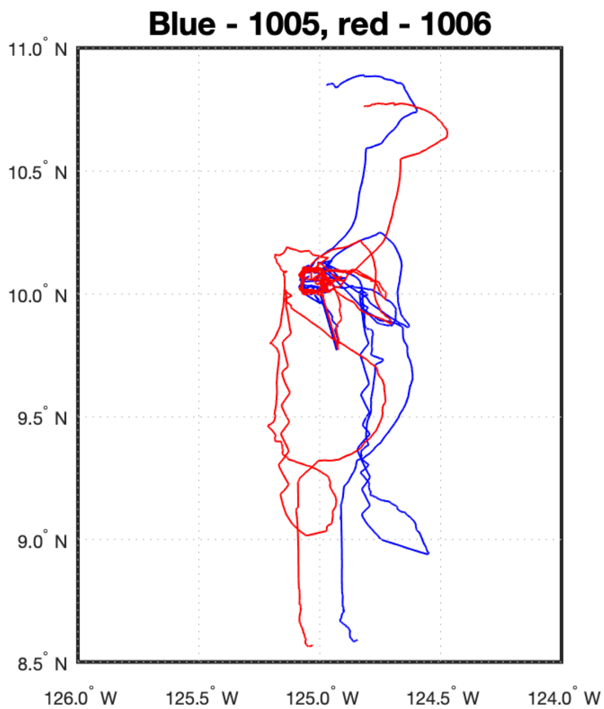


Figure 3.95. Tracks of saildrones. Tracks begin in the north and end in the south.

3.6 Other Data

3.6.1 PALs

dx.doi.org/10.5067/SPUR2-PALS0

During SPURS-2 field campaign, in situ rain rate and wind speed were measured using PAL sensors on Argo floats (Riser et al., 2019, Yang et al., 2015). Each float had both a UW ID number and a WMO ID number. The floats continue to operate, but the files in the archive cut off on Aug-20-2018. Table 5 has a list of the ID numbers and deployment dates. Figure 3.97 shows the trajectories relative to the three moorings.

Table 5. WMO ID numbers, UW ID numbers and deployment dates for the 4 PAL-equipped argo floats.

WMO ID	UW ID	Deployment date
5904668	8435	Aug-30-2106
5904762	8444	Sep-05-2016

5904775	9302	Sep-05-2016
5904777	12360	Sep-03-2016

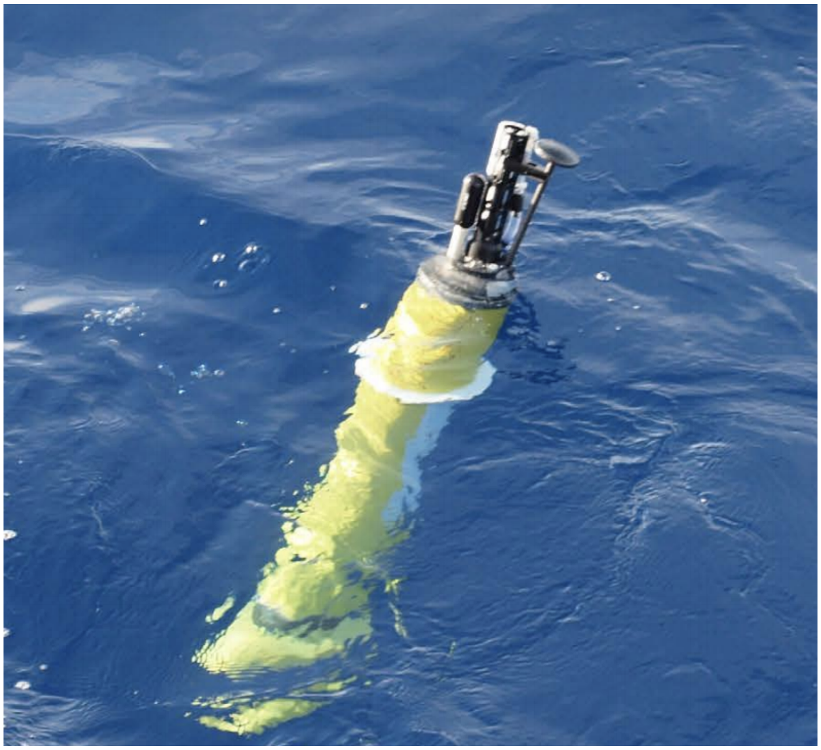


Figure 3.96. PAL sensor on an Argo float (Riser et al. 2019). The PAL hydrophone is the disk-shaped extension at the top.

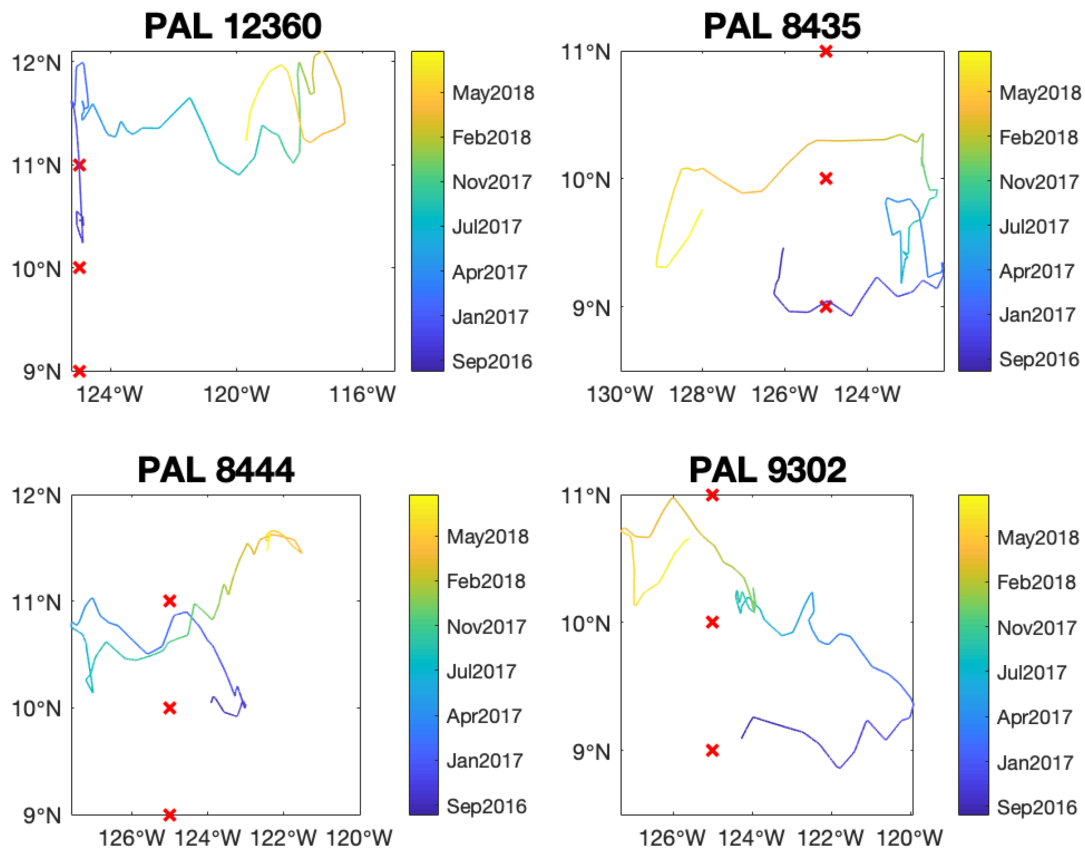


Figure 3.97. Trajectories of the PAL floats.

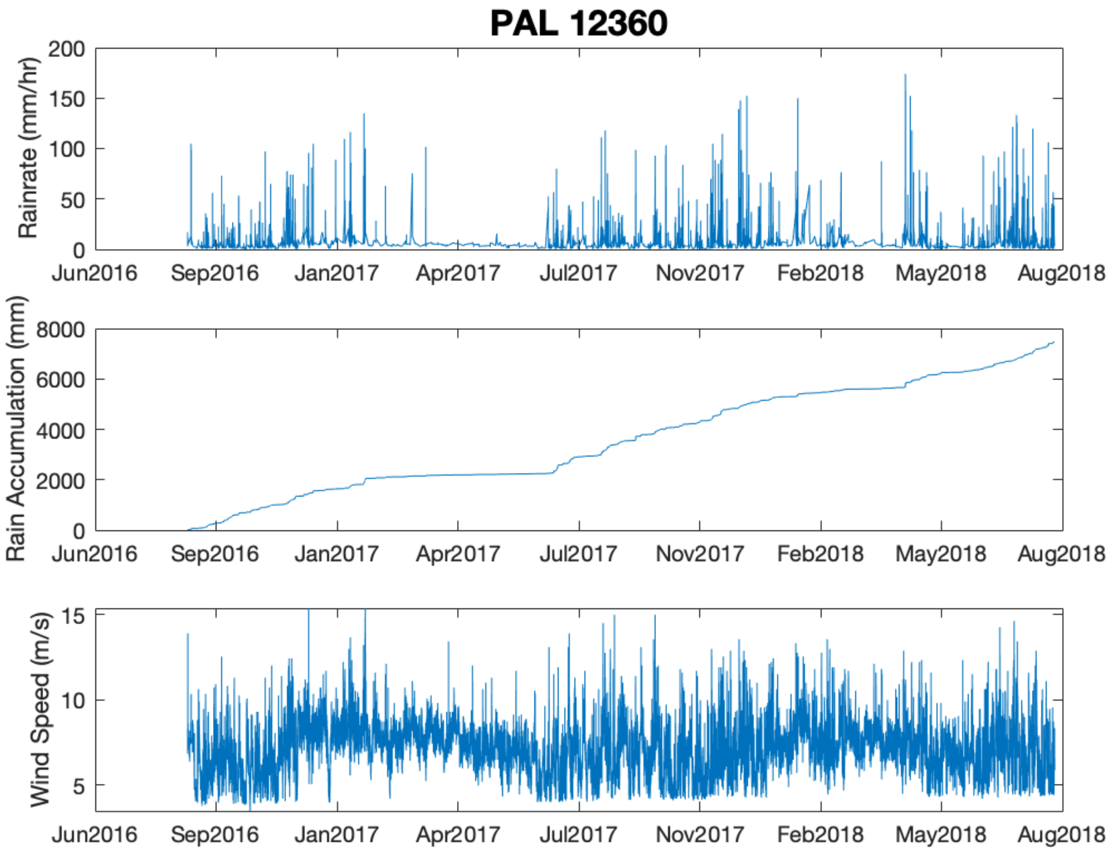


Figure 3.98. Rainrate, rain accumulation, and wind speed of the PAL 12360 sensor.

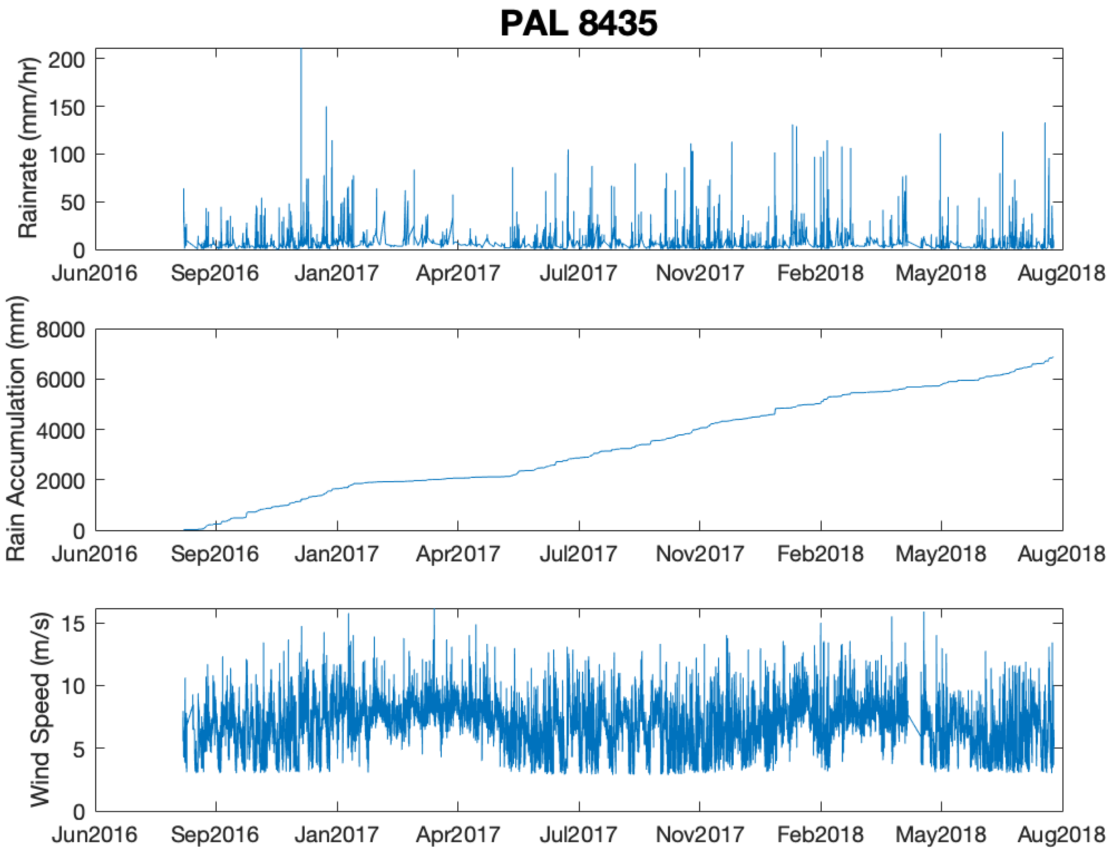


Figure 3.99. Rainrate, rain accumulation, and wind speed of the PAL 8435 sensor.

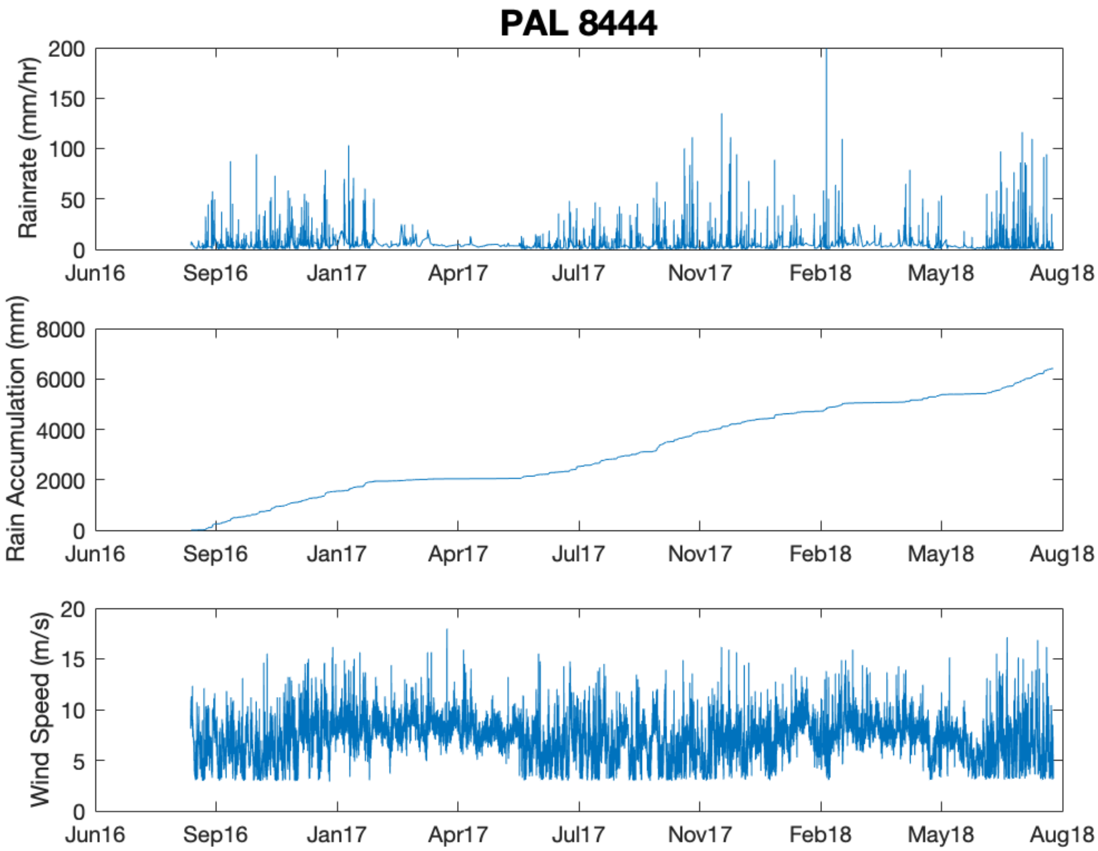


Figure 3.100. Rainrate, rain accumulation, and wind speed of the PAL 8444 sensor.

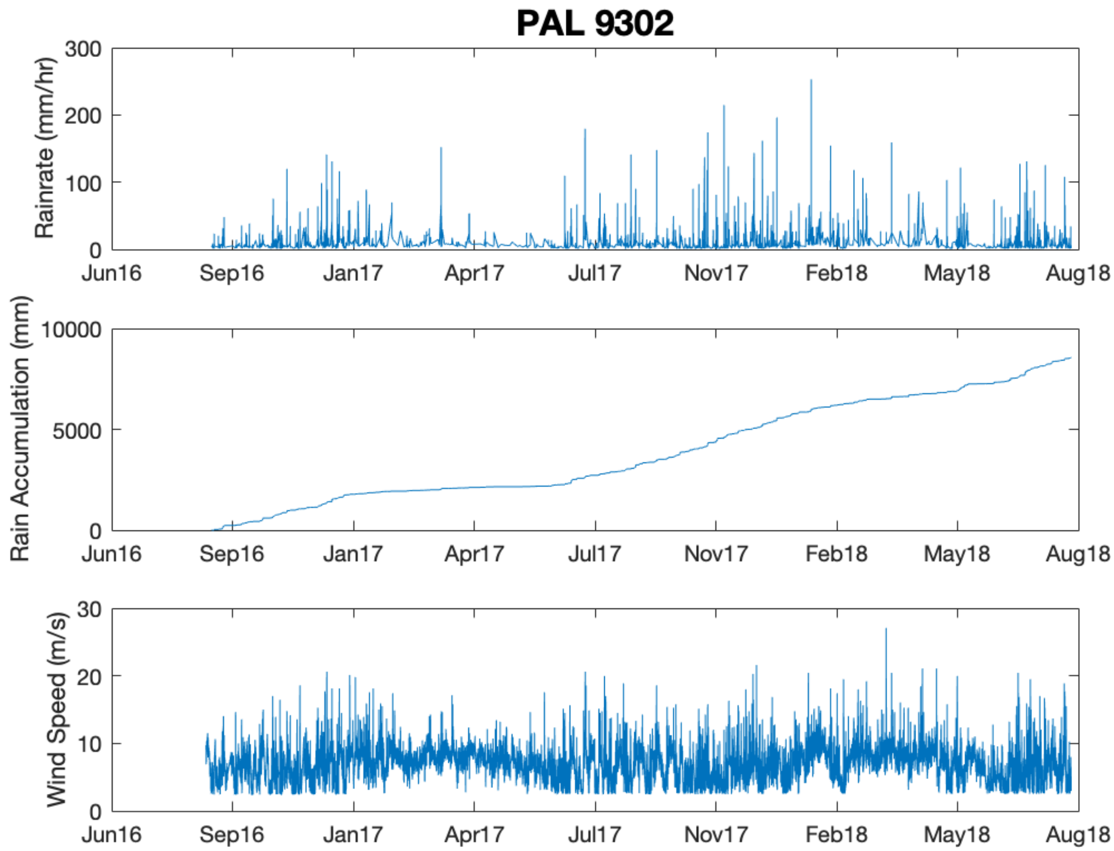


Figure 3.101. Rainrate, rain accumulation, and wind speed of the PAL 9302 sensor.

3.6.2 Synthesis SSS Product

dx.doi.org/10.5067/SPUR2-SPUR2-SYNTH0

No SSS synthesis product has been produced at this time.

3.6.3 Lady Amber

dx.doi.org/10.5067/SPUR2-LAMBR

The LA underway system (Rainville et al., 2019) collected oceanographic and meteorological data during 6 of the 8 cruises. As detailed in Table 6.

Table 6. Data collected during each LA cruise.

Cruise #	1	2	3	4	5	6	7	8
Salinity at 1m	X	✓	X	✓	✓	X	✓	X
Temperature at 1m	X	✓	X	✓	✓	✓	✓	X
Pressure at 1m	X	✓	X	✓	✓	✓	✓	X
Salinity at 2m	X	✓	✓	✓	✓	X	X	X
Temperature at 2m	X	✓	✓	✓	✓	✓	✓	X
Pressure at 2m	X	✓	✓	✓	✓	✓	✓	X
Salinity at 1cm	X	X	X	X	✓	X	✓	X
Air Temperature	X	✓	✓	✓	✓	✓	✓	X
Air Pressure	X	✓	✓	✓	✓	✓	✓	X
Relative Humidity	X	✓	✓	✓	✓	✓	✓	X
Zonal Wind Speed	X	✓	✓	✓	✓	✓	✓	X
Meridional Wind Speed	X	✓	✓	✓	✓	✓	✓	X
Vessel Heading	X	✓	✓	✓	✓	✓	✓	X
Vessel Speed	X	✓	✓	✓	✓	✓	✓	X
Rain Accumulation	X	✓	✓	✓	✓	✓	✓	X
Rainfall Rate	X	✓	✓	✓	✓	✓	✓	X

Figure 3.102. Lady Amber at port in Honolulu.

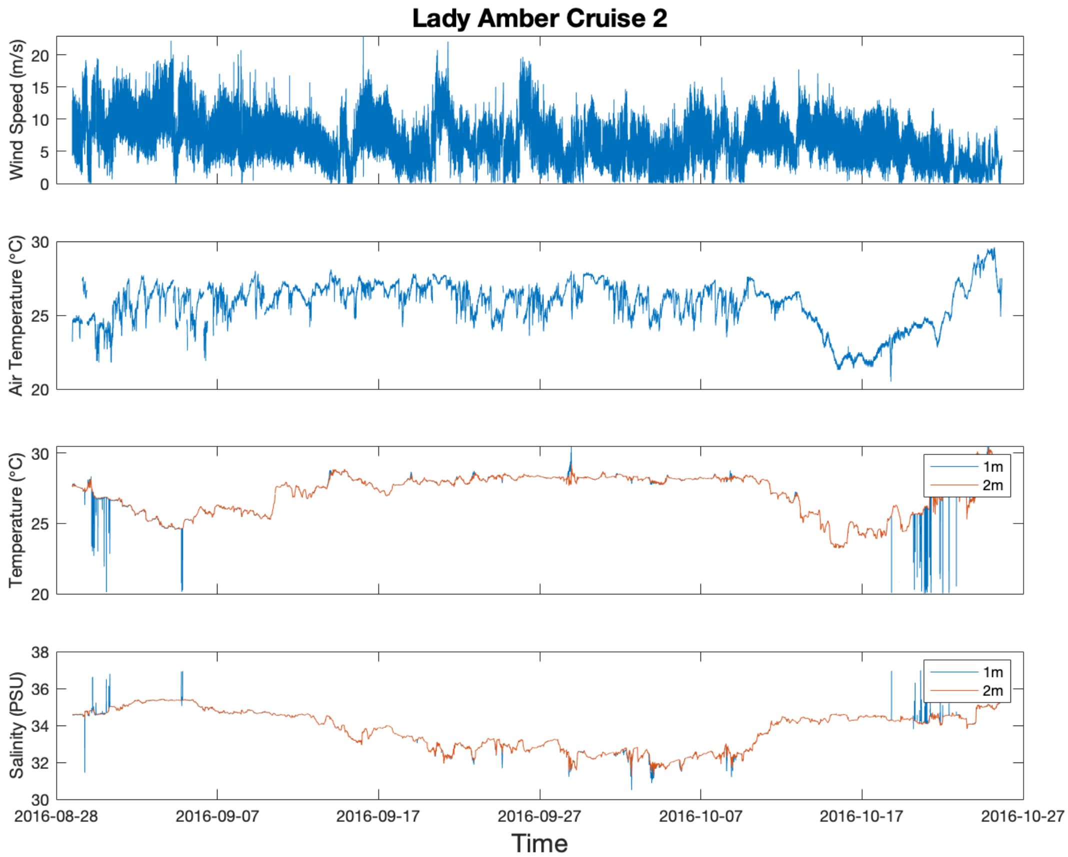


Figure 3.103. Wind speed, air temperature, seawater temperature at 1m and 2m, and seawater salinity at 1m and 2m collected during Lady Amber's cruise 2.

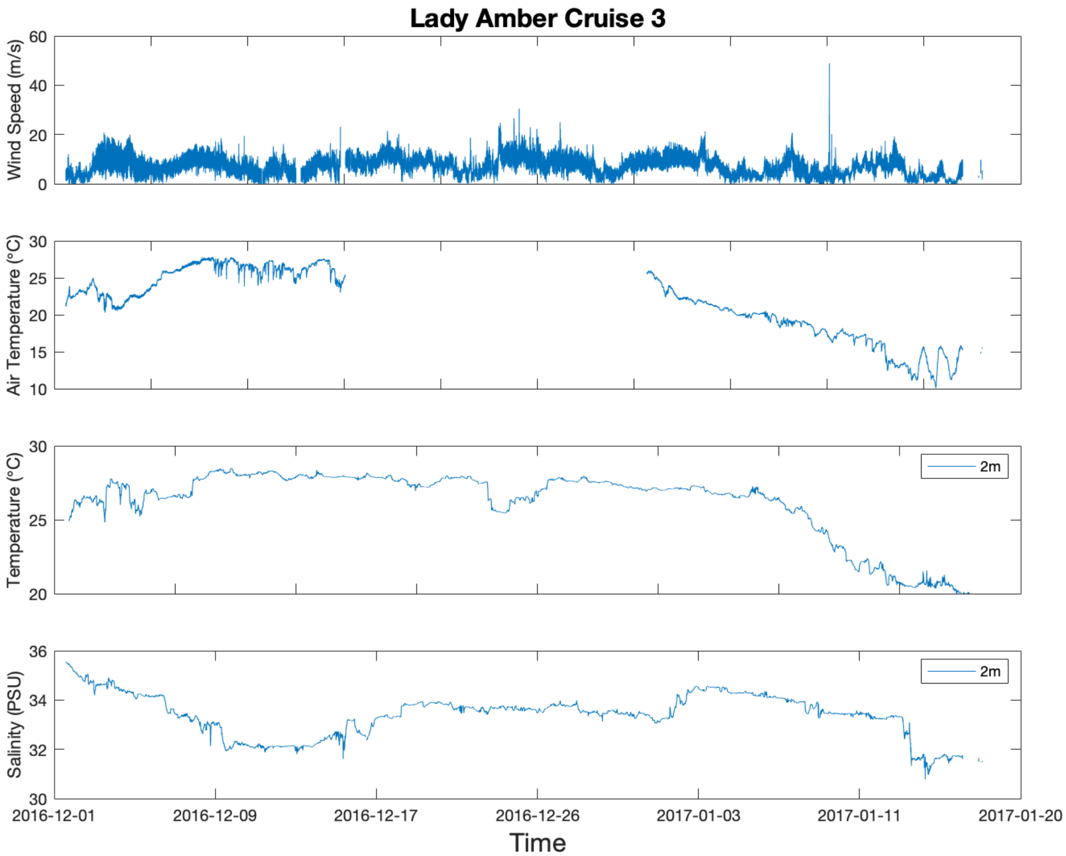


Figure 3.104. Wind speed, air temperature, seawater temperature at 2m, and seawater salinity at 2m collected during Lady Amber's cruise 3.

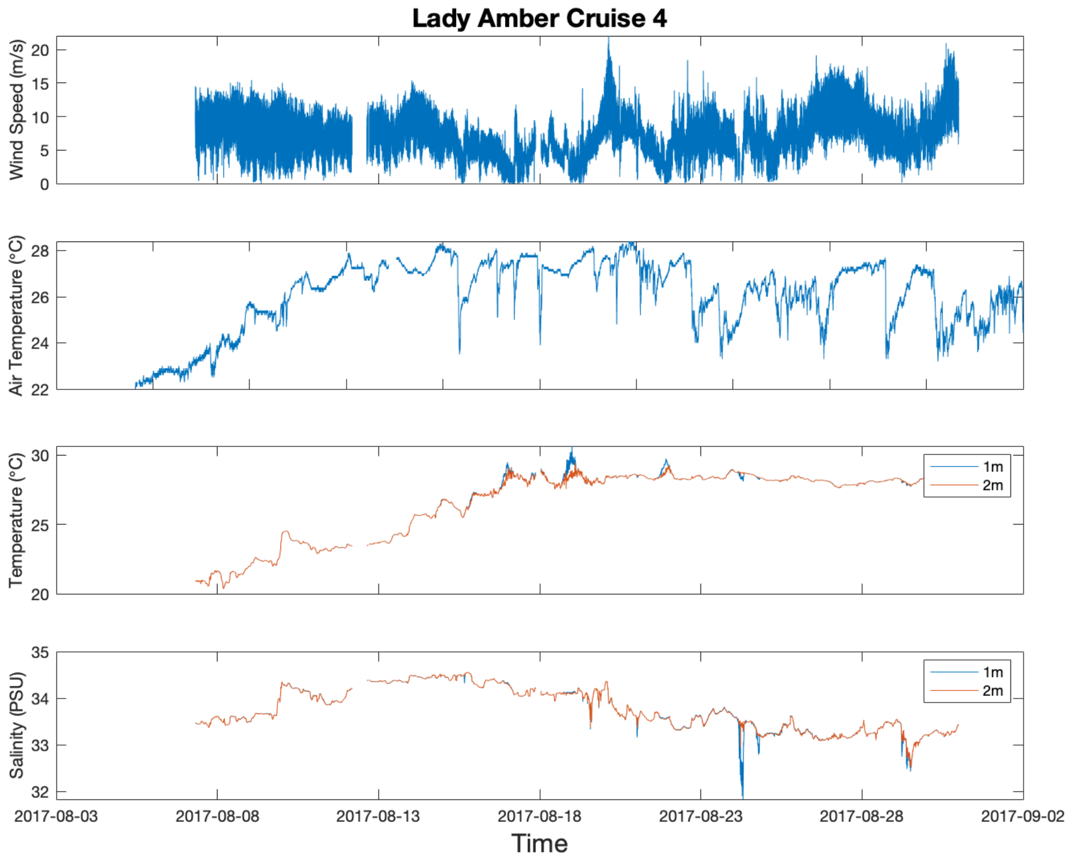


Figure 3.105. Wind speed, air temperature, seawater temperature at 1m and 2m, and seawater salinity at 1m and 2m collected during Lady Amber's cruise 4.

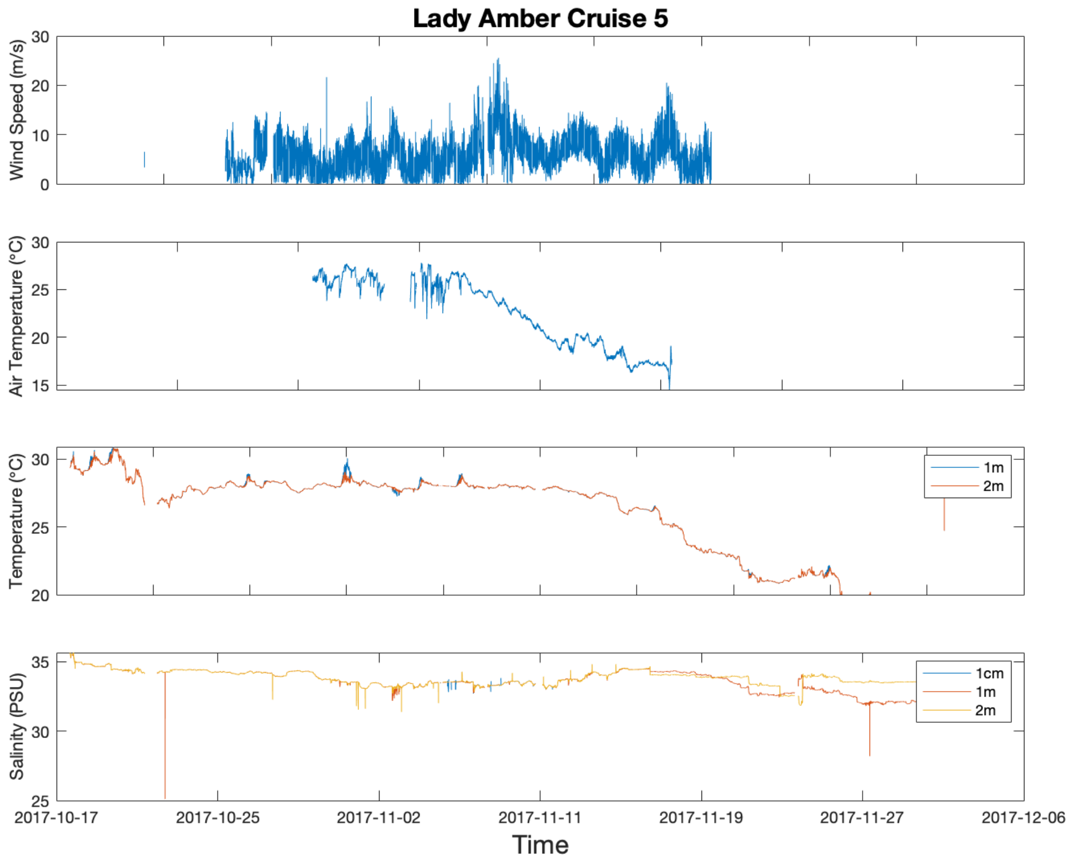


Figure 3.106. Wind speed, air temperature, seawater temperature at 1m and 2m, and seawater salinity at 1cm, 1m, and 2m collected during Lady Amber's cruise 5.

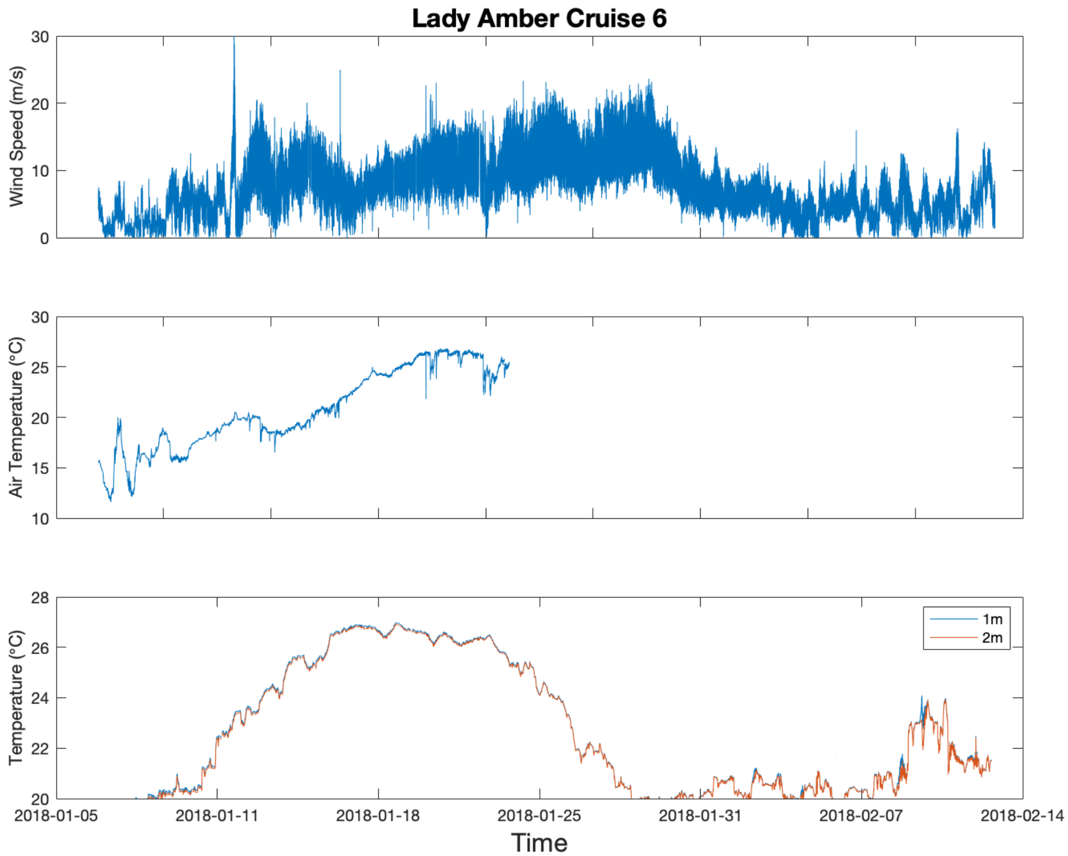


Figure 3.107. Wind speed, air temperature, and seawater temperature at 1m and 2m collected during Lady Amber's cruise 6.

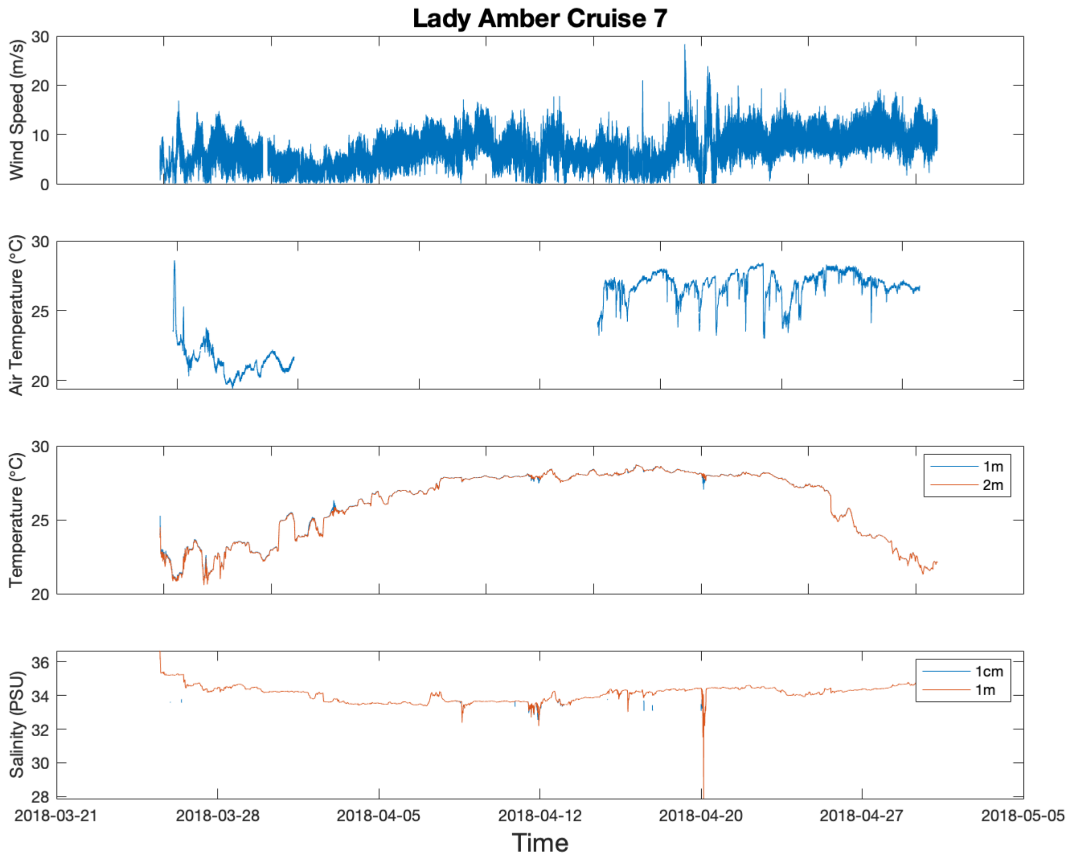


Figure 3.108. Wind speed, air temperature, seawater temperature at 1m and 2m, and seawater salinity at 1cm and 1m collected during Lady Amber's cruise 7.

4 Discussion

As is clear from this document, the SPURS-2 field campaign was a sprawling enterprise, stretching over a dozen or so institutions, three government agencies and two countries. Synthesis of the SPURS-2 data is ongoing, with preliminary results having been presented in the June 2019 issue of *Oceanography*. Not mentioned in this report is a nested high-resolution, data-assimilating model (Li et al., 2019), or, of course, contemporaneous observation of surface fields of SSH, SST, SSS and rainfall among other variables by satellite. It is hoped that this data submission report, along with the cruise reports and the other documentation available at the SPURS mission page at PO.DAAC will help future researchers make sense of the data collection and the use people made of it.

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7 Table of abbreviations

ACDD	Attribute Convention for Data Discovery
ACFT	Active Controlled Flux Technique
ADCP	Acoustic Doppler Current Profiler

CARTHE	Consortium for the Advanced Research on Transport of Hydrocarbon in the Environment
CF	Climate and Forecast
CODE	Coastal Ocean Dynamics Experiment
CSU	Colorado State University
CTD	Conductivity-Temperature-Depth
DOI	Digital Object Identifier
JPL	NASA Jet Propulsion Laboratory
LA	Schooner Lady Amber
LDL	Lagrangian Drifter Lab
NCEI	National Centers for Environmental Information
netCDF	Network Common Data Form
PAL	Passive Acoustic Listener
PICO	Platform and Instrumentation for Continuous Observations
PO.DAAC	Physical Oceanography Distributed Active Archive Center
R/V	Research Vessel
SADOS	Super Autonomous Drifting Observing Station
SBE	Seabird Electronics
SEA-POL	Sea-going Polarimetric radar
SIO	Scripps Institution of Oceanography, University of California, San Diego
SPURS-2	Salinity Processes in the Upper ocean Regional Study - 2
SSH	Sea Surface Height
SSP	Surface Salinity Profiler

SSS	Sea Surface Salinity
SST	Sea Surface Temperature
TSG	Thermosalinograph
UNCW	University of North Carolina Wilmington
UOP	Upper Ocean Processes
UNOLS	University National Oceanographic Laboratory System
URL	Universal Resource Locator
USPS	Underway Salinity Profiling System
UW	University of Washington
WMO	World Meteorological Organization
XBT	eXpendible BathyThermeograph